Solar®8000M
Patient Monitor
Service Manual

2000701-177 Revision C

GE Medical Systems
Information Technologies

gemedical.com

NOTE

Due to continuing product innovation, specifications in this manual are subject to change without notice.

NOTE

The following hardware versions are supported in this manual:

Product Code	Description
3T	Single Video, UnityView
3S	Dual Video, UnityView
SBH	Single Video ONLY

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1 Introduction

For your notes

Manual Information

Revision History

Each page of the document has the document part number and revision letter at the bottom of the page. The revision letter changes whenever the document is updated.

Revision	Comment
A	Initial release of this manual, corresponding to software version 4D.
B	Revised to clarify Octanet connection information.
C	Revised to include new release.

Manual Purpose

This manual supplies technical information for service representatives and technical personnel so they can maintain the equipment to the assembly level. Use it as a guide for maintenance and electrical repairs considered field repairable. Where necessary the manual identifies additional sources of relevant information and technical assistance.

See the operator's manual for the instructions necessary to operate the equipment safely in accordance with its function and intended use.

Intended Audience

This manual is intended for service representatives and technical personnel who maintain, troubleshoot, or repair this equipment.

Safety Information

Responsibility of the Manufacturer

GE Medical Systems *Information Technologies* is responsible for the effects of safety, reliability, and performance only if:

- Assembly operations, extensions, readjustments, modifications, or repairs are carried out by persons authorized by GE Medical Systems *Information Technologies*.
- The electrical installation of the relevant room complies with the requirements of the appropriate regulations.
- The equipment is used in accordance with the instructions for use.

General

This device is intended for use under the direct supervision of a licensed health care practitioner.

This device is not intended for home use.

Federal law restricts this device to be sold by or on the order of a physician.

Contact GE Medical Systems *Information Technologies* for information before connecting any devices to the equipment that are not recommended in this manual.

Parts and accessories used must meet the requirements of the applicable EN 60601 series safety standards, and/or the system configuration must meet the requirements of the EN 60601-1-1 medical electrical systems standard.

Periodically, and whenever the integrity of the device is in doubt, test all functions.

The use of ACCESSORY equipment not complying with the equivalent safety requirements of this equipment may lead to a reduced level of safety of the resulting system. Consideration relating to the choice shall include:

- use of the accessory in the PATIENT VICINITY; and
- evidence that the safety certification of the ACCESSORY has been performed in accordance to the appropriate EN 60601-1 and/or EN 60601-1-1 harmonized national standard.

If the installation of the equipment, in the USA, will use 240V rather than 120V, the source must be a center-tapped, 240V, single-phase circuit.

Warnings, Cautions, and Notes

The terms danger, warning, and caution are used throughout this manual to point out hazards and to designate a degree or level or seriousness. Familiarize yourself with their definitions and significance.

Hazard is defined as a source of potential injury to a person.

DANGER indicates an imminent hazard which, if not avoided, will result in death or serious injury.

WARNING indicates a potential hazard or unsafe practice which, if not avoided, could result in death or serious injury.

CAUTION indicates a potential hazard or unsafe practice which, if not avoided, could result in minor personal injury or product/property damage.

NOTE provides application tips or other useful information to assure that you get the most from your equipment.

Equipment Symbols

NOTE

Some symbols may not appear on all equipment.

ATTENTION: Consult accompanying documents.

CAUTION: To reduce the risk of electric shock, do NOT remove cover. Refer servicing to qualified service personnel.

NOTE

The rating of protection against electric shock (indicated by symbol for CF or BF) is achieved only when used with patient applied parts recommended by GE Medical Systems *Information Technologies*.

TYPE CF APPLIED PART: Isolated (floating) applied part suitable for intentional external and internal application to the patient including direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof.
[Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of EN 60601-1/UL 60601-1/CSA 601.1 Medical Standards to provide a higher degree of protection against electric shock than that provided by type BF applied parts.

TYPE BF APPLIED PART: Isolated (floating) applied part suitable for intentional external and internal application to the patient excluding direct cardiac application. “Paddles” outside the box indicate the applied part is defibrillator proof.
[Medical Standard Definition:] F-type applied part (floating/isolated) complying with the specified requirements of EN 60601-1/UL 60601-1/CSA 601.1 Medical Standards to provide a higher degree of protection against electric shock than that provided by type B applied parts.

TYPE B APPLIED PART: Non-isolated applied part suitable for intentional external and internal application to the patient excluding direct cardiac application.
[Medical Standard Definition:] Applied part complying with the specified requirements of EN 60601-1/UL 60601-1/CSA 601.1 Medical Standards to provide protection against electric shock, particularly regarding allowable leakage current.

Fuse

Equipotential

Alternating current (AC)

Power; I = ON; O = OFF

This symbol indicates that the waste of electrical and electronic equipment must not be disposed as unsorted municipal waste and must be collected separately. Please contact an authorized representative of the manufacturer for information concerning the decommissioning of your equipment.

Service Information

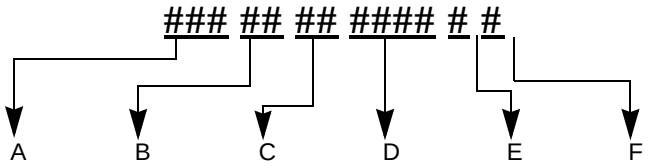
Service Requirements

Follow the service requirements listed below.

- Refer equipment servicing to GE Medical Systems *Information Technologies*' authorized service personnel only.
- Any unauthorized attempt to repair equipment under warranty voids that warranty.
- It is the user's responsibility to report the need for service to GE Medical Systems *Information Technologies* or to one of their authorized agents.
- Failure on the part of the responsible individual, hospital, or institution using this equipment to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards.
- Regular maintenance, irrespective of usage, is essential to ensure that the equipment will always be functional when required.

Equipment Identification

Every GE Medical Systems *Information Technologies* device has a unique serial number for identification. A sample of the information found on a serial number label is shown below.



	Description
A	product code[1]
B	year manufactured
C	fiscal week manufactured
D	production sequence number
E	manufacturing site
F	miscellaneous characteristic

1. The following are the Solar 8000M product codes:

Product Code	Description
3T	Single Video, UnityView
3S	Dual Video, UnityView
SBH	Single Video ONLY

For your notes

2 Equipment Overview

For your notes

System Components

Solar 8000M Patient Monitoring System

The Solar 8000M patient monitoring system consists of the following standard components:

- Solar 8000M processing unit
- Display
- Keypad and/or remote control
- Tram-rac® housing with acquisition module(s)

Additional, optional components include:

- Tram-net interface adapter (TIA)
- Clinical Information Center (central station)
- Remote display, VGA and DFP

  NOTE

  This is only available on dual display Solar 8000M systems (product code 3S).

- Printer PRN 50/PRN 50-M
- Octanet® or Unity Network® ID connectivity device

Solar 8000M Patient Monitor

The patient monitor consists of a Solar 8000M processing unit with compatible display purchased from GE Medical Systems *Information Technologies* or another vendor.

The processing unit is the center of the Solar 8000M patient monitoring system. It provides the user controls, the processors to communicate with various patient monitoring modules, and it analyzes patient data. It can display up to eight different waveforms at one time. System software may be updated using a laptop computer connected to the Solar 8000M processing unit or the Unity Network or from a Clinical Information Center (CIC) on the Unity Network.

UnityView Remote Display Controller

NOTE

This feature is only available on Solar 8000M systems with product codes 3S & 3T.

The UnityView remote display controller consists of a remote display controller with a compatible display purchased from GE Medical Systems *Information Technologies* or another vendor. The controller connects to the Unity Network and may be configured to display any patient waveforms broadcasted on the network for better visibility as a remote full-view display, or as an in-room telemetry display. System software may be updated using a laptop computer connected to the UnityView remote display controller or the Unity Network or from a Clinical Information Center (CIC) on the Unity Network.

Tram-rac Housing

The Tram-rac housing (remote acquisition case) acquires patient data for the patient monitor. There are two Tram-rac housings available for the monitor:

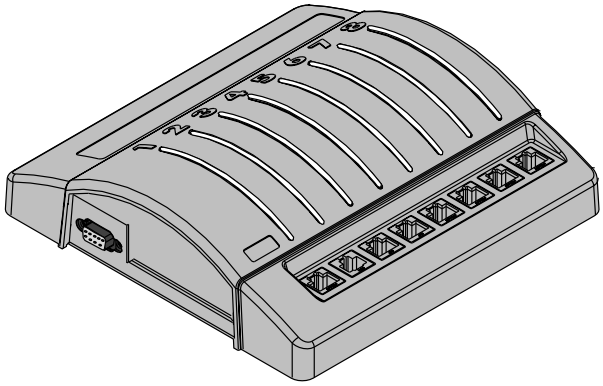
- Tram-rac 2 housing — holds a single Tram module.
- Tram-rac 4A housing — holds a Tram module and two additional single-high modules.

See the Tram-rac Housing Service Manual for additional information. Shown below is a Tram-rac 4A housing with a Tram module and two single parameter modules inserted.

005B

Connectivity Devices

The Octanet or the Unity Network ID connectivity device acquires digital data from eight individually isolated RS-232 Serial Ports. The data is collected from up to eight peripheral devices (not necessarily manufactured by GE Medical Systems *Information Technologies*), then the device transmits the formatted data to the Solar 8000M patient monitor. See the appropriate connectivity device service manual for additional information.



PRN 50/PRN 50-M Digital Writer

The PRN 50/PRN 50-M digital writer thermally records patient data on a paper strip. Any parameter or trace that can be monitored on a monitor can be graphed by the writer. Graphs initiate automatically when an alarm is activated, or they can be initiated manually from the monitor.

NOTE

The PRN 50-M digital writer is an M-Port device. To make an AutoPort device (such as PRN 50) M-Port compatible, use the AutoPort to M-Port adapter, pn 2001973-001. The adapter is not required if connecting to an Octanet.

Laser Printer

An optional laser printer can be connected directly to the monitor via one of the M-Ports. The laser printer must have a serial port, and an interface adapter is required for the cable between the laser printer and the monitor. Refer to the instructions provided in the Laser Printer Support Kit, pn 2013421-001, for details on the interface adapter and installing a serial card in a laser printer.

WARNING

SHOCK HAZARD. Laser printers are UL 60950/EN 60950 certified equipment, which may not meet the leakage current requirements of patient care equipment. This equipment must not be located in the patient vicinity unless the medical system standard EN 60601-1-1 is followed.

Do not connect a laser printer to a multiple portable socket outlet (MPSO) supplying patient care equipment. The use of an MPSO for a system will result in an enclosure leakage current equal to the sum of all the individual earth leakage currents of the system if there is an interruption of the MPSO protective earth conductor.

Remote Control/Keypad

The remote control/keypad provides all patient monitor controls on a portable component with a **TRIM KNOB** control, and allows the user to operate the patient monitor from across a room. Eighteen hard keys are configured for adult, neonatal, or operating room applications. The keypad is ‘fixed mounted’ on the front of the Solar 8000M patient monitor or on a separate holster that has various mounting configurations.

Remote Displays

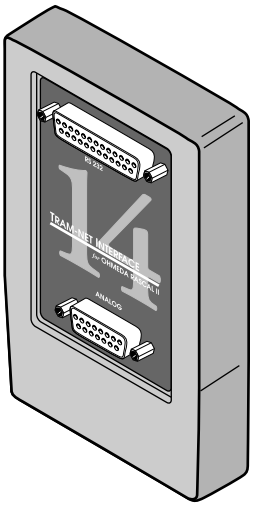
NOTE

This is only available on dual display Solar 8000M systems (product code 3S).

Depending on your Solar 8000M configuration, there are up to two VGA (CRT/ analog flat panel) ports and two DFP (digital flat panel) ports for remote viewing.

Tram-net Interface Adapter

The Tram-net interface adapter connects a specific device to the Solar 8000M patient monitor using Tram-net communication. Each adapter is preprogrammed at the factory to interface with a specific device manufactured by a company other than GE Medical Systems *Information Technologies*. For more details about the Tram-net interface adapter, refer to the Modular Patient Monitor Accessories Service Manual.



Device Compatibility

The tables in this section are current as of the publication date of this manual and are subject to change. For current information, contact your Service or Sales Representative.

Acquisition Devices

The Solar 8000M patient monitor is compatible with the following acquisition modules.

Part Number	Description
406132-001	SvO2 Module
9399-003	Dual Temp Module, YSI 700
9399-004	SURG Dual Temp Module, YSI 700
96064-004, TT400=A	Dual Temp Module, YSI 400
96064-005, TT400S=A	SURG Dual Temp Module, YSI 400
96064-010	BP/Dual Temp Module
96064-011	Surgical BP/Dual Temp Module
BPBPNIC=A	Dual BP Module
BPBPNICS=A	Surgical BP/BP Module
BPCONIC=A	BP/CO Module
BPNIC=A	BP Module
BPNICS=A	Surgical BP Module
BPTT=A, BPTT400=A	BP/Dual Temp Module
BPTTS=A, BPTTS400=A	Surgical BP/Dual Temp Module
NBPDA=A	NIBP Module - Adult
NBPDN=A	NIBP Module - Neonatal
NBPDP=A	NIBP Module - Pediatric
SLRECG=A	ECG/Resp Module
SLRECGD=A	ECG/Resp/Defib Sync Module
SLRECGSL=A	ECG/Resp/12SL Module
SLRECGSLD=A	ECG/Resp/12SL/Defib Sync Module
SLRSPO2=A	SpO2 Module
MSN=A	Capnostat Mainstream EtCO2 Module
MSSS=A	Dual CO2 Module
SAM=A	SAM Module
SAM80=A	SAM80 Module
SS=A	Side-Stream EtCO2 Module

Part Number	Description
T200=A	Tram Module w/ECG, Resp, CO, 2 BP, NIBP, SpO2
T250=A	Tram Module w/ECG, Resp, CO, 2 BP, NIBP, SpO2
T400=A	Tram Module w/ECG, Resp, CO, 3 BP, NIBP, SpO2
T450=A	Tram Module w/ECG, Resp, CO, 3 BP, NIBP, SpO2
T451=X	Tram Module w/ECG, Resp, CO, 3 BP, NIBP, SpO2 (GEMS-IT)
T451N=X	Tram Module w/ECG, Resp, CO, 3 BP, NIBP, SpO2 (Nellcor)
T451M=X	Tram Module w/ECG, Resp, CO, 3 BP, NIBP, SpO2 (Masimo)
T600=A	Tram Module w/ECG, Resp, CO, 4 BP, SpO2
T650=A	Tram Module w/ECG, Resp, CO, 4 BP, SpO2
T800=A	Tram Module w/ECG, Resp, CO, NIBP, SpO2
T800SL=A	Tram Module w/ECG, Resp, CO, NIBP, SpO2
T850=A	Tram Module w/ECG, Resp, CO, NIBP, SpO2
T850SL=A	Tram Module w/ECG, Resp, CO, NIBP, SpO2
T851=X	Tram Module w/ECG, Resp, CO, SpO2 (GEMS-IT)
T851N=X	Tram Module w/ECG, Resp, CO, SpO2 (Nellcor)
T851M=X	Tram Module w/ECG, Resp, CO, SpO2 (Masimo)
7030AAX, ABX etc.	tcpO2/pCO2 Module
REMCH=A	Respiratory Mechanics Module
ICGMOD=XXX	Impedance Cardiograph Module
BISMOD=XXX, EEG/ BISMOD=XXX	BIS/EEG Module
SLRSPO2MAS	Masimo Sp02 Module

Peripheral Devices

The Solar 8000M patient monitor is compatible with the following peripheral devices.

Product	Interface
Solar 8000M RMT	M-Port or M-Port compatible Octanet
Solar 8000M Keypad	M-Port or M-Port compatible Octanet
PRN 50	Octanet or M-Port with M-Port compatible PRN50
RAC 4A Comm	Tramnet
RAC 4A DAS	Tramnet
RAC 2	Tramnet
Octanet	Tramnet
TIA	Tramnet
Unity Network ID	M-Port
RM Module	Octanet or M-Port with M-Port compatible RM module
Polled Data Services	RS-232 1 Serial Port
Serial download	RS-232 1 Serial Port
Elo Touchscreen	R-232 2 Serial Port
RAMS	Octonet or TIA
Remote Alarm	M-Port
Laser printer	M-Port

Unity Network Devices

The Solar 8000M patient monitor is compatible with the following Unity Network devices.

Product
ADU/Pager LAN
ApexPro
CDT-LAN
Centralscope: CS 12
CIC
Dash 2000
Dash 3000/4000
Eagle 3000
Eagle 4000

Product
HL7
ICMMS/Service Web
Impact Pager
Managed Care
MARS-CRS
MUSE / MUSE NT
Octacomm
Octanet
QS
RSVP
Solar 7000/8000
Solar 9000/9500
ST Guard
Tramscope 12
Auto View
TRAM XX0
CO2 Module
ECG/RESP Module
Resp Mech Module
SAM Module
SpO2 Module
SvO2 Module
Masimo Sp02 Module
Transcutaneous Module

Interfaces

The Solar 8000M patient monitor supports the following interfaces through an Octanet connectivity device, Unity Network ID connectivity device, or TIA.

NOTE

Although this list was accurate at the time of publishing, it may no longer be comprehensive. Contact your sales representative to obtain current information.

Product Mfg	Model	TIA	Octanet	Unity Network ID	TIA PN	DIDCA PN
Nellcor PB	7200E/SPE/AE	X	X	X	TIAPB7200AE=X	420915-001
Siemens	SV 900C/D/E	X	X	X	TIASS900CD=X	420915-002
Engstrom	EAS 9000/9010/9020	X	X		TIAE9010=X	420915-003
Datex	Capnomac Ultima	X	X	X	TIADU=X	420915-004
Allied Health Care	Bear 1000	X	X	X	TIAB1000=X	420915-005
Hamilton	Veolar/Amadeus	X	X	X	TIAHV=X	420915-007
Nellcor PB	Infant Star 500/950	X	X	X	TIAIS=X	420915-008
Nellcor PB	Adult Star 1500/2000	X	X	X	TIAAS=X	420915-009
Siemens	SV 300	X	X	X	TIASS300=X	420915-011
GEMS IT	RAMS	X	X		TIARAMS=X	420915-012
GEMS IT	Tauras/Xpar/Comm		X			420915-013
Ohmeda	Rascal II Anes Gas	X	X	X	TIAOHRASII=X	420915-014
Ohmeda	5250 RGM: Resp Gas	X	X	X	TIAOH5250=X	420915-015
N Amer Drager	Narkomed 2B/2C/3/4/GS	X	X	X	TIANARKO=X	420915-016
Drager	Babylog 8000	X	X	X	TIABBL8000=X	420915-017
Taema	Alys		X			420915-018
Ohmeda	7800/7810		X	X		420915-019
Bird	8400ST/6400ST/VIP	X	X	X	TIABIRD=X	420915-020
Drager	Cato		X	X		420915-021
Novametrix	840/860 (TCO2M)	X	X	X	TIANOVA840=X	420915-022
Radiometer	TINA™ (TCM3)	X	X	X	TIATINA=X	420915-023
Baxter Edwards	Vigilance	X	X	X	TIAVIGILANCE=X	420915-024
Abbott	Q-Vue/Q2	X	X	X	TIAQVUE=X	420915-025
Abbott	LifeCare 5000		X	X		420915-026
Baxter	Flowgard 6201/6301		X	X		420915-027
Alaris Medical	560M/570		X	X		420915-028
Alaris Medical	Gemini PC1/PC2/PC2TX/PC4		X	X		420915-029

Product Mfg	Model	TIA	Octanet	Unity Network ID	TIA PN	DIDCA PN
Bard	CritiCore		X	X		420915-030
GEMS IT	Test DIDCA		X	X		420915-031
Hellige	SMU EVO			X		420915-032
Nellcor PB	N-200		X	X		420915-033
Nellcor PB	N-1000/N-2500			X		420915-034
Siemens	SC 9000			X		420915-035
Drager	Cicero PM 8060 (25 pin)		X	X		420915-036
Drager	Cicero B/C		X			420915-037
Drager	Julian		X	X		420915-038
Drager	Cicero EM (25 pin)		X	X		420915-039
Drager	Evita	X	X	X	TIAEVITA=X	420915-040
Drager	Evita 2	X	X	X	TIAEVITA2=X	420915-041
Drager	Evita 2 dura	X	X	X	TIAEVITA2D=X	420915-042
Drager	Evita 4	X	X	X	TIAEVITA4=X	420915-043
Drager	Cicero EM (9 pin)		X	X		420915-044
GEMS IT	Respiratory Mechanics	X	X		TIARMECH=X	(internal) 420915-048
Ohmeda	7900		X	X		420915-049
Ohmeda	Aestiva 3000		X	X		420915-050
Drager	Cicero PM 8060 (9 pin)		X	X		420915-051
Aspect	A-2000 BIS		X			420915-056
Diametrics	IRMA		X			420915-057
Novametrix	NICO		X			420915-058
MIE	Kestrel		X			420915-059
Hamilton	Galileo		X	X		420915-060
Puritan-Bennett	PB840			X		420915-063
Nellcor PB	N-395			X		420915-069
Drager	Evita XL			X		420915-070
GEMS IT	PRN50 Solar 8000M Remote Control (Adult) Solar 8000M Remote Control (OR) Solar 8000M Remote Control (Neo) Solar 8000M Keypad (Adult) Solar 8000M Keypad (OR) Solar 8000M Keypad (Neo)		X			(internal)

Product Mfg	Model	TIA	Octanet	Unity Network ID	TIA PN	DIDCA PN
Linde	MicroGas 7650			X		420915-072
Drager	Savina			X		420915-073
Drager	Primus			X		420915-074
Drager	Fabuis GS			X		420915-075
Siemens	Servo-i			X		420915-077
Alaris Medical	IVAC Signature 7130, 7230			X		420915-079

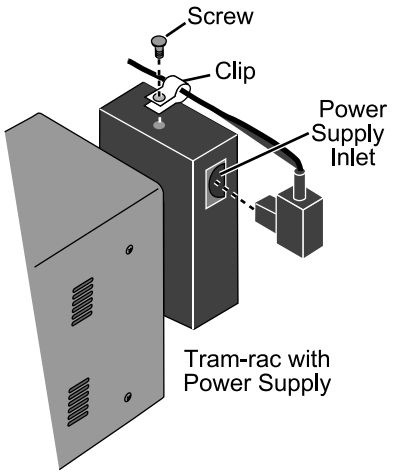
3 Installation

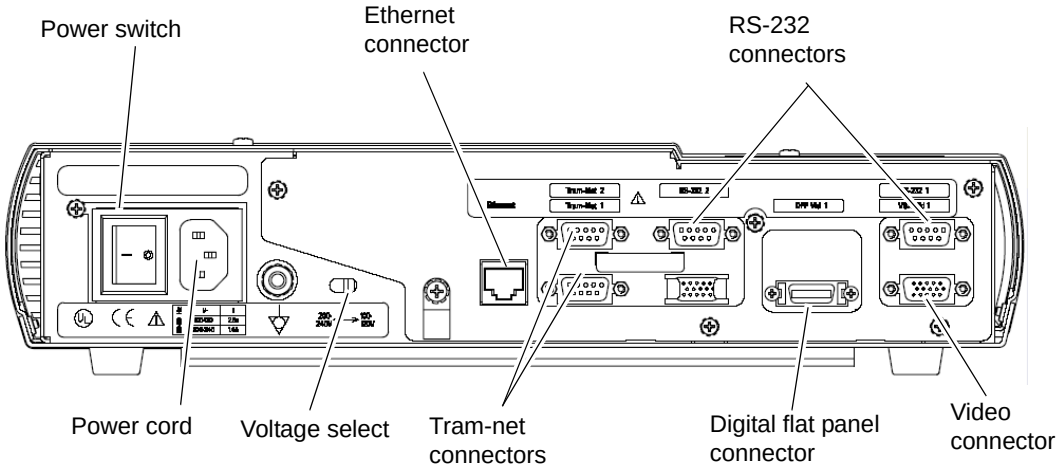
For your notes

Connections

Back Panel Connections

Connect the power cord to the power supply inlet on the back of the Solar 8000M patient monitor. If using a Tram-rac with power supply, connect the power cord as shown.





NOTE

The number of video connectors varies by configuration. Only Solar 8000M systems with product code 3S have dual video capability.

CAUTION

Equipment damage. Connect all peripheral equipment before plugging the power cord into an AC outlet. Otherwise, connectors may be damaged.

TRAM-NET

TRAM-NET provides the network for communication with bedside peripherals.

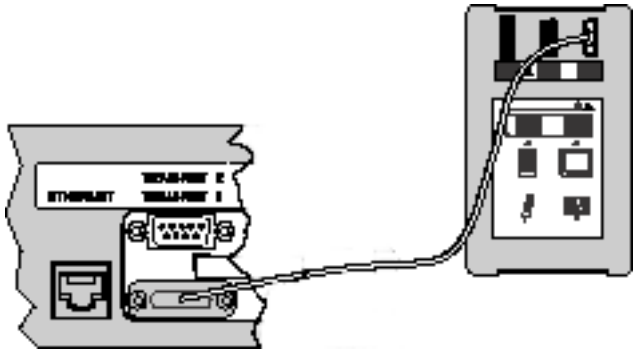
NOTE

If two Tram-racs are connected in any configuration, one must have a power supply.

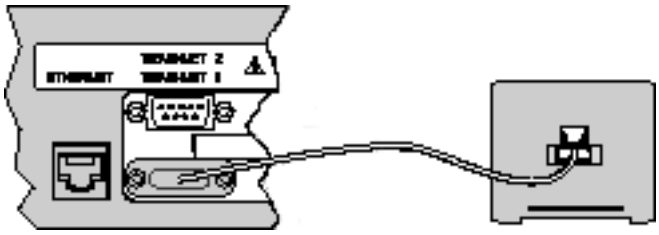
The following devices connect to either of the two **TRAM-NET** ports on the Solar 8000M monitor. The connector is a 9-pin, D-type.

- Tram-rac 4a housing with or without power supply
- Tram-rac 2 housing
- TIA (Tram-net Interface Adapter)
- Octanet
- Tram-rac 4 housing with or without power supply
- Tram-rac 3 housing with or without power supply

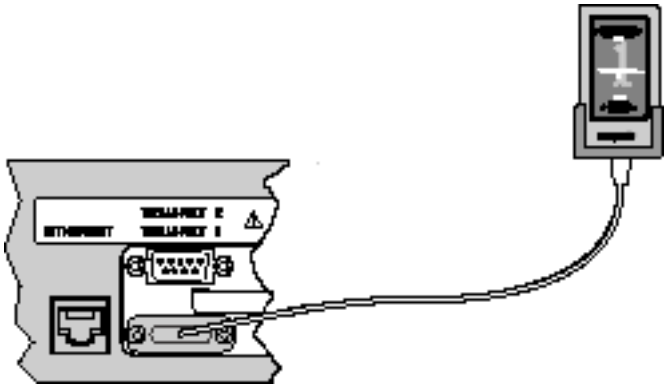
Tram-rac 4a Housing



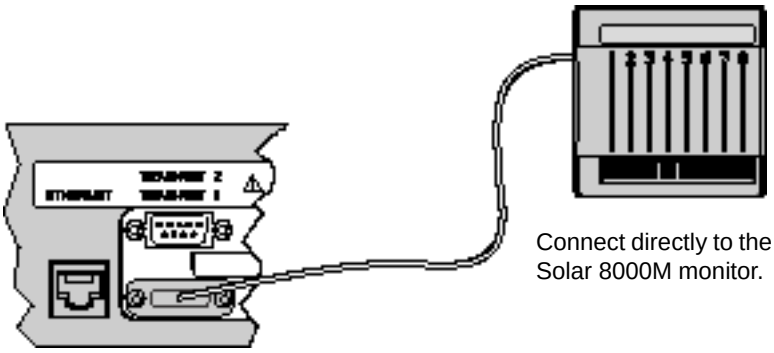
Tram-rac 2 Housing



Tram-net Interface Adapter



Octanet

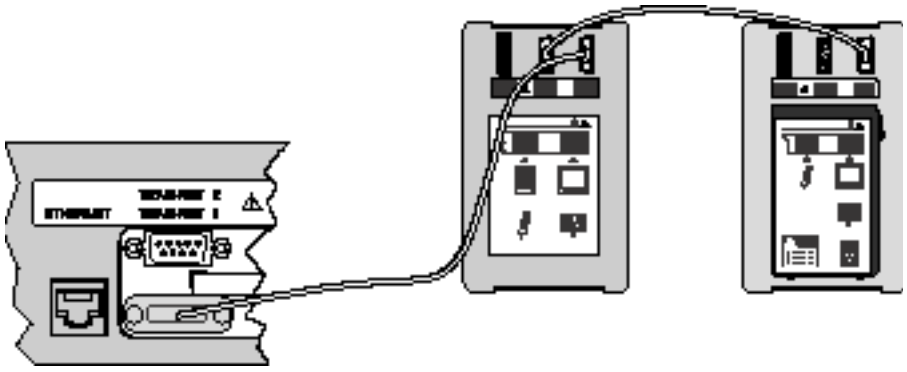


Connect directly to the Solar 8000M monitor.

NOTE

This is the only valid configuration for Octanet.

Tram-rac Housings with and without Power Supply



CAUTION

Equipment damage. Connect the Octanet and Tram-rac housing to the Solar 8000M patient monitor BEFORE plugging the power cord into an AC outlet. Connecting these devices to a powered Solar 8000M patient monitor could damage connectors.

ETHERNET

The **ETHERNET** connector provides an ANSI/IEEE 802.3 10BaseT Ethernet standard interface to the Unity Network. The connector is an 8-pin, RJ-45 type.

VGA VID 1 and 2

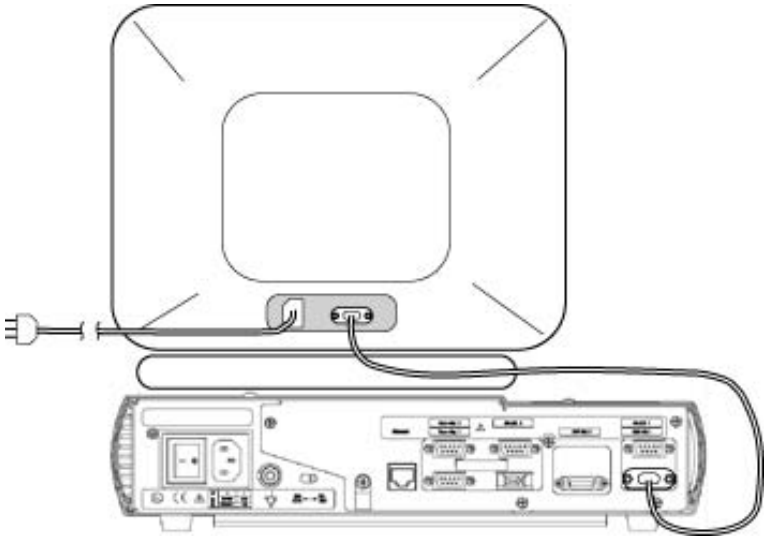
NOTE

The number of video connectors varies by configuration. VGA VID 2 is only available on dual display Solar 8000M systems (product code 3S).

The two VGA connectors provide an interface to analog (VGA) displays. The connector is a 15-pin, high density D type.

WARNING

Do not connect a monochrome display to the Solar 8000M patient monitor. Visual alarm indictors may not appear properly, resulting in a hazard to the patient.



DFP VID 1 and 2

NOTE

DFP VID 2 is only available on dual display Solar 8000M systems (product code 3S).

Two DFP (Digital Flat Panel) connectors provide an interface to digital displays. The connector is a 20-pin, MDR type.

RS-232-1

The RS-232-1 serial connector provides an interface to a PC for software upgrades, or polled-parameter service. The connector is a 9-pin, D type.

RS-232-2

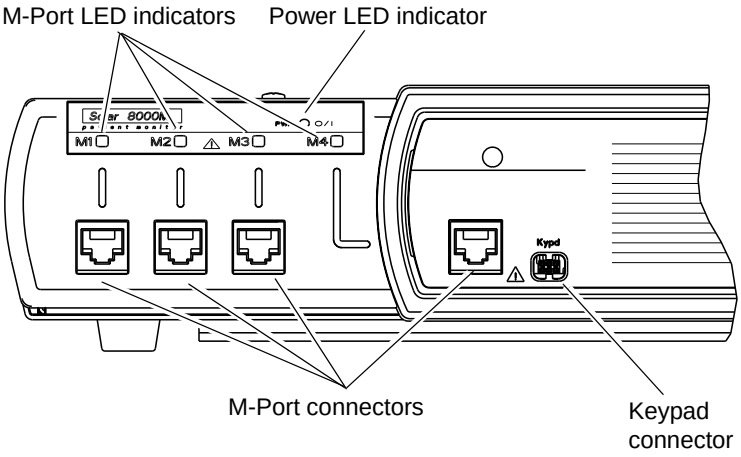
The RS-232-2 serial connector provides a touchscreen interface. The connector is a 9-pin, D type.

NOTE

Use cable 2006733-00X for touchscreen connection. The cable supplied with the monitor will not work.

Front Panel Connectors and Indicators

The front panel connectors consist of four M-Ports. Each port has a LED indicator.



M-Ports

M-Port means multi-protocol and supports Ethernet 10BaseT, RS-232, 1 wire identification, and is MIB (Medical Information Bus) compliant. M-Ports support AutoPort devices, but an AutoPort to M-Port adapter, PN 2001973-001, is required. The adapter must connect to the AutoPort device, not the M-Port host (the Solar 8000M patient monitor).

The following devices connect directly to the M-Ports. The connector is an 8-pin RJ-45 type.

- Solar 8000M remote control
- Solar 8000M keypad
- PRN 50-M digital writer
- RM-M respiratory mechanics module
- Remote Alarm Terminal (Nurse Call and Alarm Light System)
- Laser printer (requires a serial port on the printer and an interface adapter to connect to the monitor)
- Unity Network ID connectivity device

The following devices connect to M-Port hosts using AutoPort to M-Port adapter PN 2001973-001.

- PRN-50 digital writer with AutoPort
- Respiratory mechanics module with AutoPort

NOTE

AutoPort to M-Port adapter PN 2001973-001 is required for connecting AutoPort devices to M-Ports. Plug the adapter end labeled **AutoPort** into the AutoPort device.

A keypad connector is also provided so the keypad can be plugged directly into the Solar 8000M.

Keypad/Remote Control

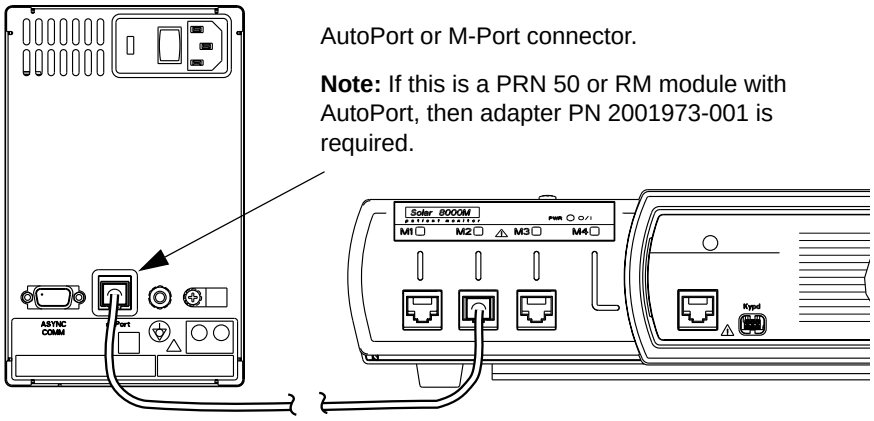
The keypad/remote control is DIDCA programmed for specific care areas (adult, neonatal, or operating room).

NOTE

The error message *WARNING: REMOTE MISMATCHED WITH MONITORING MODE* displays if a mismatched keypad/remote control is connected to the Solar 8000M patient monitor.

PRN-50 Digital Writer and Respiratory Mechanics Module

The figure below shows the PRN-50-M digital writer connected to one of the M-Ports. The RM-M respiratory mechanics module has similar connections.

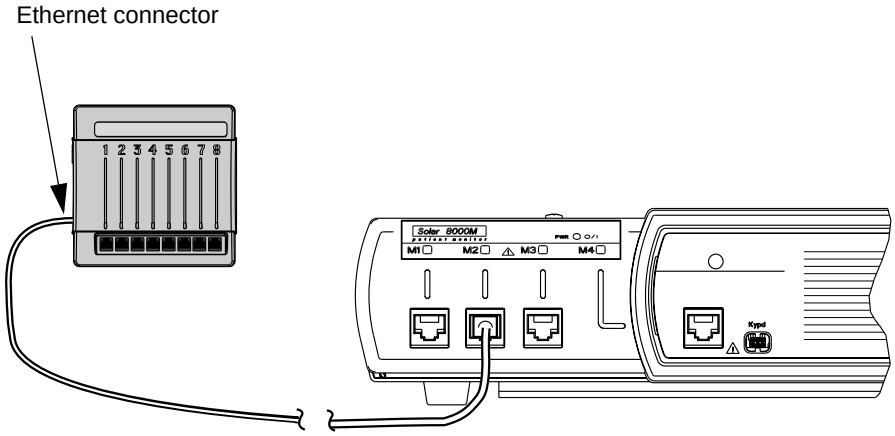


Unity Network ID Connectivity Device

The figure below shows the Unity Network ID connectivity device connected to one of the M-Ports.

NOTE

This connection requires that the Unity Network ID connectivity device IP address is a 10.X.X.X address. Refer to the Unity Network ID connectivity device service manual for more details.



Laser Printer

Refer to the instructions provided in the Laser Printer Support Kit, pn 2013421-001, for serial card installation instructions and interconnection instructions for the laser printer and monitor.

WARNING

SHOCK HAZARD. Laser printers are UL 60950/EN 60950 certified equipment, which may not meet the leakage current requirements of patient care equipment. This equipment must not be located in the patient vicinity unless the medical system standard EN 60601-1-1 is followed.

Do not connect a laser printer to a multiple portable socket outlet (MPSO) supplying patient care equipment. The use of an MPSO for a system will result in an enclosure leakage current equal to the sum of all the individual earth leakage currents of the system if there is an interruption of the MPSO protective earth conductor.

Indicators

A green LED indicates that the unit is connected to an AC power source and the power switch is turned on. There is a green/yellow LED above each M-Port indicating the M-Port status.

- Solid green indicates the device is communicating properly.
- Slow flashing yellow indicates the device has been identified, but there is no communication.
- Flashing yellow indicates that too many identical devices are connected or the device cannot be identified

Refer to Chapter 5, Troubleshooting, if an LED is not green.

Power Up

NOTE

Check power voltage at your location and set power to either 120 V or 240V.

After making all connections, plug the power cord into an AC wall outlet, turn the power switch to **1** (on), and turn on the display. The power LED illuminates and after about 10 seconds a display appears.

If the Solar 8000M patient monitor does not work properly, refer to Chapter 5, Troubleshooting. Be sure to write down the listed settings before replacing the processor pcb. (See “Before Replacing the Processor pcb” on page 5-14.)

Tram-net Communication

Overview

The Solar patient monitor uses two distinct local area networks:

- Tram-net communication, and
- Ethernet communication.

Consider Tram-net as a small area network (SAN) contained in one room or at the patient bedside. Consider Ethernet as the local area network (LAN) for room to room communication or communication between patient monitors, central stations, and other GE Medical Systems *Information Technologies* equipment throughout the hospital.

NOTE

GE Medical Systems *Information Technologies* highly recommends using a 'private' LAN to connect Unity products. The purpose of the Unity Network is to connect only Unity devices for the exchange of patient data and room-to-room communication. Adding non-Unity devices (PCs, laptops, desktops, etc.) may compromise the ability of the Unity Network to meet its intended use.

A 'private' LAN is not the same as a private IP address.

This local area network links all patient monitors, central stations, and other GE Medical Systems *Information Technologies* equipment throughout the hospital.

The **TRAM-NET** connector makes a Tram-net small area network available for the peripheral devices. The Tram-net controller resides within the main processor which provides efficient data transfer by sharing main memory.

Internal Hub

Tram-net is a small network that offers ample flexibility, a high rate of communication, and relatively inexpensive cabling. Data is transmitted at the rate of 921.6K bits per second. It uses a star topology, sometimes referred to as a rooted tree topology. This means that the wiring of the network can be pictured as a star or a series of stars. The center of each star is called a hub, and the points of the star are called nodes. There are cables between the nodes and the hubs, but no cables exist between nodes.

Data is acquired at a node, and is transmitted through a hub to all the other nodes. Each node has an address so data will be received by the node with the correct destination address. It is impossible for a node to communicate with another node without the data going through a hub somewhere along its journey. The hub controls all of the data 'traffic' in the system.

In a Tram-net system, the head hub is contained in the patient monitor, but there will be intermediate hubs in the Tram-rac housing and Tram module as well.

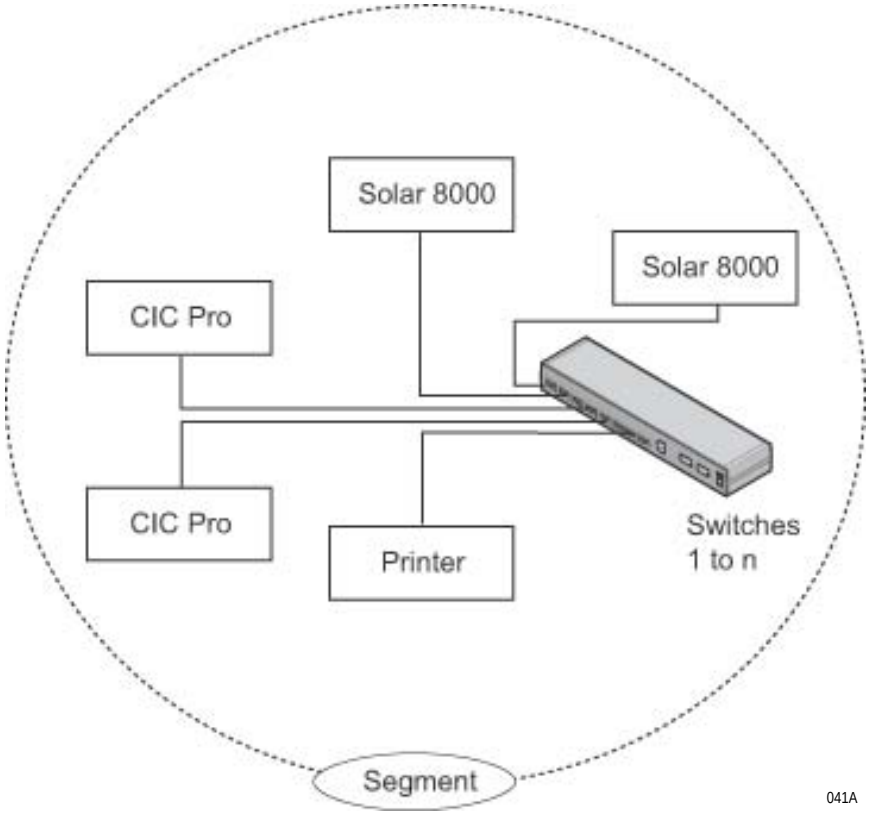
Ethernet Communication

About Ethernet

The GE Unity Network uses Ethernet for device to device communications. This local area network links all patient monitors, clinical information centers, and other GE equipment throughout the hospital. Depending on the construction of the hospital, thick-net, thin-net, or CAT-5 twisted pair cabling is used. The Solar 8000M is designed to be used with twisted-pair cabling. Consult GE when trying to interface with either thick-net or thin-net cabling. The real-time GE Unity Network operates at 10 Mbps, half-duplex.

Twisted Pair

Twisted pair is the most popular cabling because it is easy to install and flexible to work with. It uses the star topology with a switch as the hub of the segment. A maximum of 100 meters or 328 feet is the longest length of twisted pair cable allowed. The maximum number of devices on the GE Unity Network is 1,000.



Network Terms

Node

Each network device or node is assigned a MAC address number and requires a network connection to interface between the network device and the network.

MAC address

A 48-bit address assigned by the manufacturer to uniquely identify a node of the network. This is also known as the Ethernet address.

Switch

To implement the star topology, each network device is connected to a network switch. The switch passes all network data between each network device in the star segment. Typically, the switch supports 12 to 48 network devices and may be linked to other switches to form larger networks.

Segment

A network segment is comprised of all devices connected to 1 or many switches which are in-turn connected together to form a larger network. The boundaries of the segment are defined by networking equipment that regulate the flow of packets into and out of the segment (e.g. routers and switches).

IP Address

A 32-bit (IPv4) address assigned by the user (either statically or dynamically from a server) to uniquely identify the packets from a device for routing purposes.

Subnet

A subnet is a logical segment of a larger network that shares a common IP address range as defined by a subnet mask. Proper subnetting can improve the performance and security of a network. Solar 8000 series monitors support classful subnetting.

For your notes

4 Maintenance

For your notes

Maintenance Schedule

Manufacturer Recommendations

To help ensure the equipment remains in proper operational and functional order, adhere to a good maintenance schedule. The manufacturer recommends that the following be performed by service personnel upon receipt of the equipment, every 12 months thereafter, and each time the unit is serviced:

- Visual Inspection
- Cleaning
- Electrical Safety Tests
- Checkout Procedure
- Clearing the Stored Patient Data Memory: Admit and discharge a test patient every 12 months to clear the monitor's stored patient data memory.

Manufacturer Responsibility

WARNING

Failure on the part of all responsible individuals, hospitals or institutions, employing the use of this device, to implement the recommended maintenance schedule may cause equipment failure and possible health hazards. The manufacturer does not, in any manner, assume the responsibility for performing the recommended maintenance schedule, unless an Equipment Maintenance Agreement exists. The sole responsibility rests with the individuals, hospitals, or institutions utilizing the device.

Preventive Maintenance

The message *"EC1"* will appear on the monitor to the left of the ECG parameter block after 395 days of operation. This message is a reminder that it is time to perform preventive maintenance procedures on the monitor. Perform all of the maintenance procedures listed under "Manufacturer Recommendations" above.

Visual Inspection

The Solar 8000M patient monitor and its components should be carefully inspected prior to installation, once every 12 months thereafter and each time the equipment is serviced.

- Carefully inspect the equipment for physical damage to the case, the display screen, and the keypad. Do not use the monitor if damage is determined. Refer damaged equipment to qualified service personnel.
- Inspect all external connections for loose connectors or frayed cables. Have any damaged connectors or cables replaced by qualified service personnel.
- Inspect the display face for marks, scratches, or other damage. Physical damage to a CRT display face may pose an implosion hazard. Have the CRT replaced by qualified service personnel if necessary.

Cleaning

Cleaning Precautions

Use one of the following approved solutions:

- Cidex solution
- Sodium hypochlorite bleach (diluted)
- Mild soap (diluted)
- Lint-free cloth
- Dust remover (compressed air)

To avoid damage to the equipment surfaces, NEVER use the following cleaning agents:

- organic solvents,
- ammonia based solutions,
- acetone solution,
- alcohol based cleaning agents,
- Betadine solution,
- a wax containing a cleaning substance, or
- abrasive cleaning agents.

Exterior Cleaning

Clean the exterior surfaces with a clean, lint-free cloth and one of the cleaning solutions listed in the table above.

- Wring the excess solution from the cloth. Do not drip any liquid into open vents, switches, plugs, or connectors.
- Dry the surfaces with a clean cloth or paper towel.

Cleaning the Display

To clean the display, follow the recommendations of the display's manufacturer. In general you will need to use a soft, clean, lint-free cloth dampened with a glass cleaner.

CAUTION
To avoid getting liquid into connector openings, do not spray glass cleaning or general cleaning solutions directly onto the product's surface.

Cleaning the Touch Screen Display

1. Turn OFF the mains power switch on the monitor and disconnect it from the power source.
2. Clean the screen with an AMMONIA FREE glass cleaner and lint free cloth.

CAUTION
Do not spray any glass cleaning solution or any general cleaning solutions directly onto the monitor's display surface. Always dampen the towel and then clean the screen.

Electrical Safety Tests

General

Electrical safety tests provide a method of determining if potential electrical health hazards to the patient or operator of the device exist.

Recommendations

GE Medical Systems *Information Technologies* recommends that you perform all safety tests presented in this chapter.

- upon receipt of the device (monitor and its associated equipment),
- every twelve months thereafter,
- each time the main enclosure is disassembled or a circuit board is removed, tested, repaired, or replaced, and
- record the date and results on the “Maintenance/Repair Log” included at the end of this chapter.

These instructions are intended for every component in the system. If the Tram-rac housing does not have its own power supply, it should remain connected to the monitor throughout the safety tests.

WARNING
Failure to implement a satisfactory maintenance schedule may cause undue equipment failure and possible health hazards. Unless you have an Equipment Maintenance Contract, GE Medical Systems *Information Technologies* does not in any manner assume the responsibility for performing the recommended maintenance procedures. The sole responsibility rests with the individual or institution using the equipment. GE Medical Systems *Information Technologies* service personnel may, at their discretion, follow the procedures provided in this manual as a guide during visits to the equipment site.

Test Conditions

Electrical safety tests may be performed under normal ambient conditions of temperature, humidity, and pressure.

Test Equipment

The recommended test equipment required to perform electrical safety tests is listed below.

Item	Specification
Leakage Current Tester	Equivalent to the circuits shown

Digital Multimeter (DMM)	AC volts, ohms
Ground Bond Tester	0 – 1 ohm
ECG Test Body	All leads together

Power Outlet Test

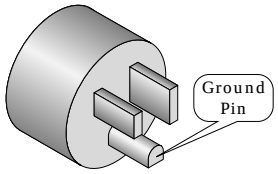
Before starting the tests, the power outlet from which the monitoring device will get electrical power must be checked. This test checks the condition of the power outlet to ensure correct results from leakage tests.

For international power outlets, refer to the internal standards agencies of that particular country. Use a digital multimeter to ensure the power outlet is wired properly.

If other than normal polarity and ground is indicated, corrective action must be taken before proceeding. The results of the following tests will be meaningless unless a properly wired power outlet is used.

Ground (Earth) Integrity

Listed below are two methods for checking the ground (earth) integrity, “Ground Continuity Test” and “Impedance of Protective Earth Connection.” These tests determine whether the device's exposed metal and power inlet's earth (ground) connection have a power ground fault condition.



Perform the test method below that is required by your country/local governing safety organization.

Ground Continuity Test

Completion of this test is checked by the following steps:

1. Disconnect the device under test from the power outlet.
2. Connect the negative (–) lead of the DMM to the protective earth terminal (ground pin in power inlet connector) or the protective earth pin in the mains plug (ground pin in power cord). Refer to the US 120Vac power cord figure above.
3. Set the DMM to the milliohm (mΩ) range.
4. Connect the positive (+) lead of the DMM to all exposed metal surfaces on the device under test. If the metal surfaces are anodized or painted, scrape off a small area in a inconspicuous place for the probe to make contact with the metal.
5. Resistance must read:
   - 0.1 ohm or less without power cord
   - 0.2 ohms or less with power cord

Impedance of Protective Earth Connection

This test, unlike a ground continuity test, will also stress the ground system by using special ground bond testers.

This test normally is only required as a manufacturing production test to receive safety agency compliance (e.g., EN 60601-1).

Some country agencies do require this test after field equipment repairs (e.g., Germany's DIN VDE 0751 standards).

Consult your country/local safety agency if in question.

Compliance is checked by the following steps:

1. A current not less than 10A and not exceeding 25A from a current source with a frequency of 50 or 60 Hz with a no-load voltage not exceeding 6 V is passed for at least 5 seconds (s) through the protective earth terminal or the protective earth pin in the mains plug and each accessible metal part which could become live in case of failure in basic insulation.
2. The voltage drop between the parts described is measured and the impedance determined from the current and voltage drop. It shall not exceed the values indicated.

For equipment without a power supply cord the impedance between the protective earth terminal and any accessible metal part which is protectively earthed shall not exceed 0.1 ohms.

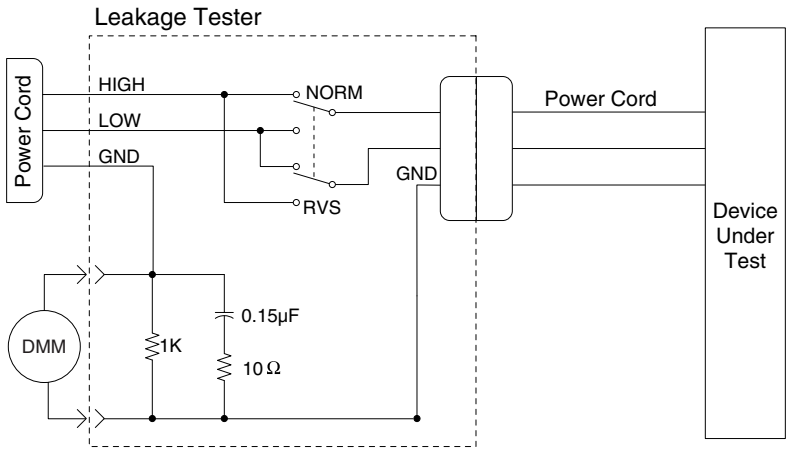
For equipment with a power supply cord the impedance between the protective earth pin in the mains plug and any accessible metal part which is protectively earthed shall not exceed 0.2 ohms.

When taking this measurement, move the unit's power cord around. There should be no fluctuations in resistance.

Ground (Earth) Wire Leakage Current Tests

Perform this test to measure current leakage through the ground (earth) wire of the equipment during normal operation.

1. Configure the leakage tester like the circuit shown below.



DMM set to measure AC voltage

2. Connect the power cord of the device under test to the power receptacle on the leakage tester.

   NOTE

   The device under test is to be tested at its normal operating voltage.

3. Set the power switch of the device under test to ON.
4. Read the current leakage indicated on DMM.
5. Set the polarity switch on the leakage tester to RVS (reverse).
6. Read the current leakage indicated on DMM.

   NOTE

   If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Medical Systems *Information Technologies* Technical Support.

   - 300 microamperes (0.3 volts on the DMM), and the device under test is powered from 100-120 V/50-60 Hz.
   - 300 µA (0.3 volts on the DMM), and the device under test is powered from a centered-tapped 200-240 V/50-60 Hz, single phase circuit.
   - 500 µA (0.5 volts on the DMM), and the device under test is powered from a non-center-tapped, 200-240 V/50-60 Hz, single-phase circuit.

   NOTE

   Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and EN limits are different.

7. Set the power switch of the device under test to OFF.

NOTE

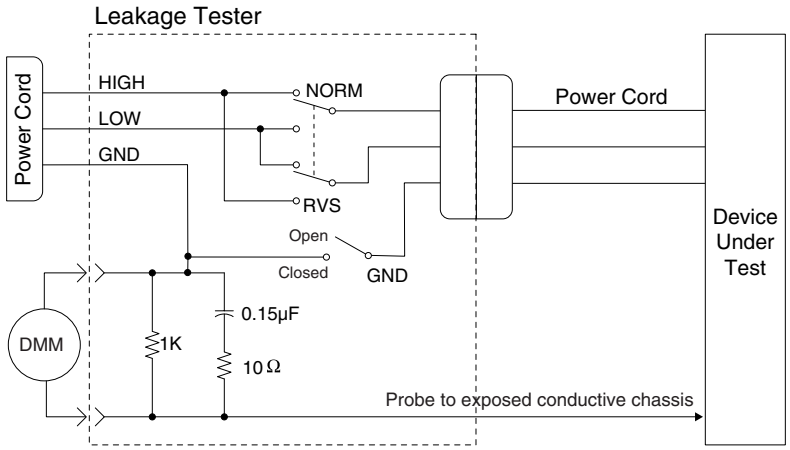
The DMM plus leakage tester network shown is the circuitry defined by the UL 60601-1 standard for measuring leakage current.

The measuring devices defined by various standard organizations (EN, UL, etc.) produce almost identical test measurement results.

Enclosure Leakage Current Test

Perform this test to measure current leakage through exposed conductive surfaces on the device under test during normal operation.

1. Configure the leakage tester like the circuit shown below with GND switch OPEN and polarity switch NORM.



DMM set to measure AC voltage

2. Connect probe to an unpainted, non-anodized chassis ground on the device under test.
3. Set the power switch of the device to ON.
4. Read the current leakage indicated on DMM.

NOTE

Center-tapped and non-center-tapped supply circuits produce different leakage currents and the UL and EN limits are different.

5. Set the polarity switch to RVS.

6. Read the current leakage indicated on DMM.

   NOTE

   If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Medical Systems *Information Technologies* Technical Support.

   - 300 microamperes (0.3 volts on the DMM), and the device under test is powered from 100-120 V/50-60 Hz.
   - 300 µA (0.3 volts on the DMM), and the device under test is powered from a centered-tapped 200-240 V/50-60 Hz, single phase circuit.
   - 500 µA (0.5 volts on the DMM), and the device under test is powered from a non-center-tapped, 200-240 V/50-60 Hz, single-phase circuit.

7. Set the GND switch on the leakage tester to CLOSED.
8. Read the current leakage indicated on DMM.
9. Set the polarity switch to RVS.
10. Read the current leakage indicated on DMM.

    NOTE

    If the reading is greater than the specification below, and the device under test is powered from 100-240 V/50-60 Hz, the device under test fails. Contact GE Medical Systems *Information Technologies* Technical Support.

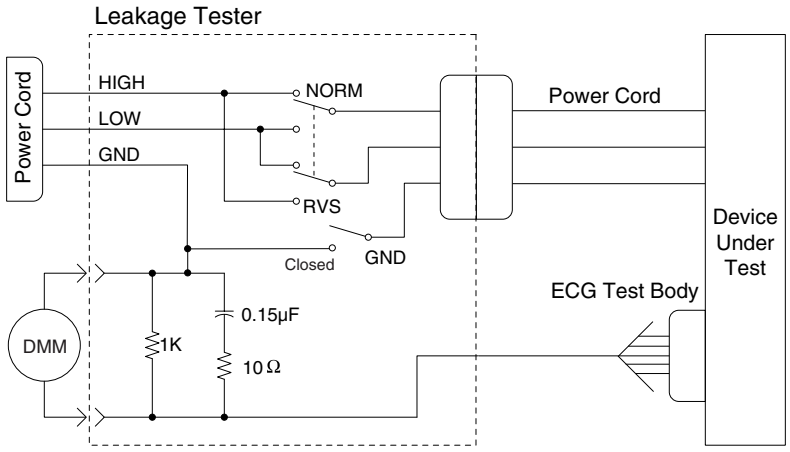
    - 100 microamperes (0.1 volts on the DMM), and the device under test is powered from 100-240 V/50-60 Hz.

11. Set the power switch of the device under test to OFF.

Patient (Source) Leakage Current Test

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from the ECG/RESP connector of the device to ground.

1. Configure the leakage tester like the circuit shown below with GND switch OPEN and polarity switch NORM.



DMM set to measure AC voltage

2. Connect an ECG test body to the ECG/RESP connector of the device under test.
3. Set the power switch of the device to ON.
4. Read the leakage current indicated on the DMM.
5. Change the leakage tester polarity switch to the RVS position.
6. Read the leakage current indicated on the DMM.

   NOTE

   If either reading is greater than 50 µA (0.05 volts on the DMM), the device fails this test. Contact GE Medical Systems *Information Technologies* Technical Support.

7. Change the GND switch to the CLOSED position.
8. Read the leakage current indicated on the DMM.
9. Change the leakage current switch to the RVS position.
10. Read the leakage current indicated on the DMM.

    NOTE

    If either reading is greater than 10 µA (0.01 volts on the DMM), the device fails this test. Contact GE Medical Systems *Information Technologies* Technical Support.

11. Set the power switch of the device to OFF.

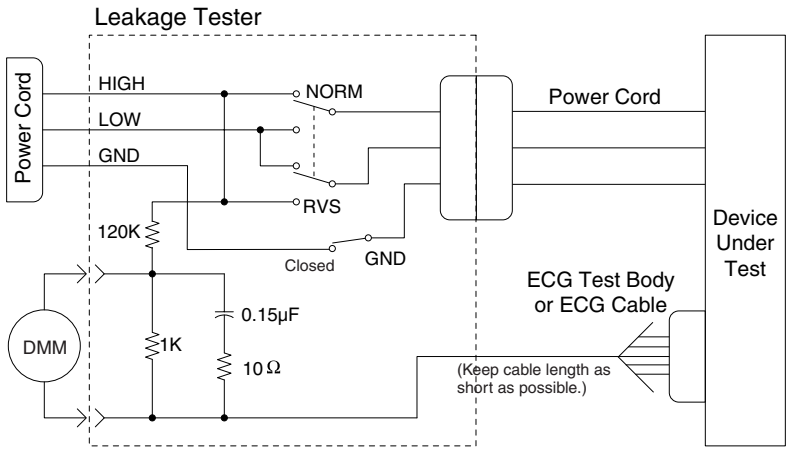
    NOTE

    The AAMI and EN single fault condition (ground open) is 50 µA, whereas the normal condition (ground closed) is less.

Patient (Sink) Leakage Current Test
(Mains Voltage on the Applied Part)

This procedure only applies to Class I (grounded/earthed) equipment, and measures the leakage current from a mains voltage source into the ECG/RESP connector.

1. Configure the leakage tester like the circuit shown below with GND switch CLOSED and polarity switch NORM.



DMM set to measure AC voltage

WARNING
Shock hazard. The following step causes high voltage at the test body. Do not touch the test body.

2. Set power switch on the device to ON.
3. Read leakage current indicated on DMM.
4. Change the leakage tester polarity switch to the RVS position.
5. Read the leakage current indicated on the DMM.

NOTE
If either reading is greater than the appropriate specification below, the device under test fails. Contact GE Medical Systems *Information Technologies* Technical Support.

- 10 µA (0.01 volts on the DMM) at 120 VAC using the test body.
- 20 µA (0.02 volts on the DMM) at 240 VAC using the test body.
- 50 µA (0.05 volts on the DMM) at 120-240 VAC using the ECG cable.

NOTE
The 10 and 20 µA limits are based on internal design standards. The 50 µA limit is common to all standards. AAMI ES-1 standard requires using the patient cable.

6. Set the power switch on the device to OFF.

Test Completion

1. Disconnect the leakage tester from the power outlet.
2. Disconnect all test equipment from the device.
3. Disconnect the device power cord from the leakage tester.

Checkout Procedure

General

This procedure tests the functions of the monitor, Tram-rac housing and associated communication networks. For the Tram module and input modules checkout procedures, refer to their appropriate service manuals.

Required Tools/Special Equipment

See the chart below for the equipment necessary to perform this checkout procedure. Equivalent equipment may be substituted.

Item	Manufacturer and Part Number/Model
Tram 100-851 module	GE Medical Systems *Information Technologies* any
BP module	GE Medical Systems *Information Technologies* any
Multifunctional Micro-simulator	MARQ III or equivalent
Oscilloscope	Tektronix 2215
Port Checkout DIDCA	420915-031
Cable, category 5 (cat 5)	418335-002
AutoPort to M-Port Adapter	2001973-001

Procedure

Complete the following steps in the order presented. Failure to attain any of the listed results indicates a malfunction.

1. Confirm that all components of the monitoring system are correctly connected as described in Chapter 3, Installation.
2. Place the Tram module into the top two slots of the Tram-rac housing. Verify that the power indicator illuminates.
3. Configure the monitor display with as many waveforms as possible. Refer to the appropriate monitor operator's manual, if necessary.
4. The waveforms should look clean (no noise).

Solar 8000M/UnityView Display Check

NOTE
This check only applies to Solar 8000M systems with product codes 3S & 3T.

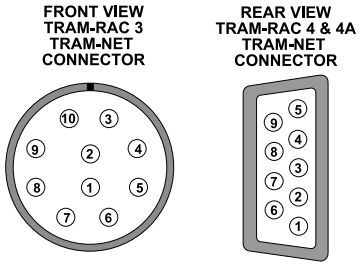
Refer to the specific manufacturer’s documentation.

Touchscreen

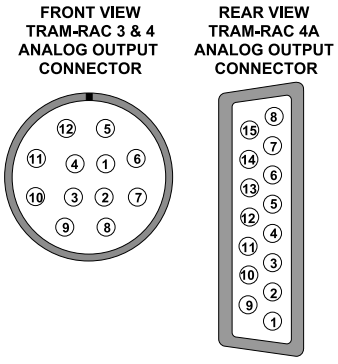
Verify that touching a parameter box displays the appropriate screen.

Tram-rac Housing Check

1. Verify that the power LED is ON at the Tram-rac housing.
2. Disconnect and reconnect the Tram-rac housing communication cable. Verify the recovery of the waveforms.
3. If the Tram-rac housing has additional slots for input modules, insert a BP module. Connect simulator and verify communication to the monitor. Repeat for each slot.
4. If the Tram-rac housing has an optional power supply, check the following on the connector that applies to your equipment.



   - Verify +16.5V is NOT present at pin 5 of the TRAM-NET connector with respect to pin 9.
   - Verify +16.5V is NOT present at pin 5 with respect to chassis ground of the Tram-rac housing.
5. The following step does not apply for a Tram-rac 2 housing. Check the analog output connector (yellow) using an oscilloscope. Observe a signal at the appropriate pins found in the next table. The output signal is dependent upon which Tram and input module functions are activated at the monitor. Tram-rac 3 and 4 housings use the front round connector.



Analog Output Signals			
Pins for D-Type Connector	Pins for Round Connector	Signal Source	Tram-rac 4A Bezel Number for BP Output
Pin 1	Pin 8	Signal GND for Tram Waveforms	–
Pin 2	Pin 2	Trace I (ECG II[1])	Tram[1]
Pin3	Pin 6	Tram BP3 or SPO_2 Value	Tram[1]
Pin 4	–	Reserved for Future Use	–
Pin 5	Pin 4	Tram ART 1 or BP1	Tram
Pin 6	Pin 9	Slot 3 Series 7000 Waveform A (Right Side or Module)	Parameter 6
Pin 7	Pin 11	Slot 4 Series 7000 Waveform A (Right Side or Module)	Parameter 8
Pin 8	Pin 8	Signal GND for Series 7000 Waveforms	–
Pin 9	Pin 1	Tram ECG II	Tram[1]
Pin 10	Pin 3	Tram ECG V	Tram[1]
Pin 11	Pin 7	Tram BP4 or RESP	Tram[1]
Pin 12	–	Reserved for Future Use	–
Pin 13	Pin 5	Tram BP2 or SPO_2 Waveform	Tram
Pin 14	Pin 10	Slot 3 Series 7000 Waveform B (Left Side or Module)	Parameter 5
Pin 15	–	Slot 4 Series 7000 Waveform B (Left Side or Module)	Parameter 7

1. The top displayed trace on the monitor is present unless AVR, AVL, or AVF leads are used, then lead II is output.

M-Port Check

1. Insert the AutoPort to M-Port adapter into the Port Checkout DIDCA.
2. Connect the M-Port side of the AutoPort to M-Port adapter to one of the M-Ports using the category 5 cable.
3. Verify that the M-Port status LED illuminates green. (LED remains illuminated for a short time after the cable is removed.)
4. Repeat the above steps for all available M-Ports.

If an LED is anything but steady green, refer to Chapter 5, Troubleshooting.

Tram-net Communication Check

1. Plug the Tram-rac housing cable into each of the two Tram-net connectors.
2. Verify that the waveforms recover on the monitor display each time the cable is reconnected.

Unity MC Network Check

1. Disconnect the patient cable from the Tram module and verify alarms at the central station.
2. From the MAIN menu, select *MORE MENUS -> VIEW OTHER PATIENTS -> SELECT A BED TO VIEW*. Verify that the list includes beds other than your own.
3. Select another bed and verify that the selected bed's data displays.

Keypad/Remote Control Check

1. Plug the keypad or remote control into an M-port.
2. Check all functions of the **TRIM KNOB** control and 18 hard keys. Verify a response at the monitor display.
3. Check that the backlight is on and lights the keys evenly.
4. Activate Boot Code as follows:
   - Hold down **NBP Go/Stop** and **Zero All**.
   - Press and release the **TRIM KNOB** control.
   - Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
5. Select *Service Menu -> Tools Menu*.
6. Use password "**mei**^" to open *Service and Diagnostic Tools Menu.*
7. Select *M-Port Tools -> Show M-Port #X Serial Incoming Data*. (Where X = the M-Port number.)
8. If the message, "*No incoming data read*" appears, nothing is connected to the M-Port. Connect the keypad/remote control or choose the correct M-Port.
9. As the columns of numbers scroll, press the keys and **TRIM KNOB** control. Verify that the numbers change as keys are pressed.
10. Exit Boot Code.

Tram-net Interface Check

1. Connect the Tram-net interface assembly and device. Use the appropriate Tram-net interface assembly manual and device manual for interconnection directions.
2. Observe correct type of device identified at the monitor.
3. Simulate and observe waveform on monitor.

Octanet and Unity Network ID Check

For the Octanet and Unity Network ID connectivity devices checkout procedures, see the appropriate connectivity device service manual.

Printer Check

Press **Graph Go/Stop** and verify that the printer responds correctly.

Completion

This completes the checkout procedure.

- Disconnect all test equipment.
- Return the monitor and Tram-rac housing to service.

Maintenance Checklist

Use the following checklist to ensure maintenance completion.

“Visual Inspection” on page 4-4

1. ____ General
2. ____ Connectors
3. ____ Display

“Cleaning” on page 4-5

1. ____ Exterior Cleaning
2. ____ Cleaning the Display
3. ____ Cleaning the Touch Screen Display

“Electrical Safety Tests” on page 4-7

1. ____ Power Outlet Test
2. ____ Ground (Earth) Integrity
3. ____ Ground (Earth) Wire Leakage Current Tests
4. ____ Enclosure Leakage Current Test
5. ____ Patient (Source) Leakage Current Test
6. ____ Patient (Sink) Leakage Current Test

“Checkout Procedure” on page 4-16

1. ____ General
2. ____ Solar 8000M/UnityView Display Check
3. ____ Touchscreen Check
4. ____ Tram-rac Housing Check
5. ____ M-Port Check
6. ____ Tram-net Communication Check
7. ____ Unity MC Network Check
8. ____ Keypad/Remote Control Check
9. ____ Tram-net Interface Check
10. ____ Octanet and Unity Network ID Check
11. ____ Printer Check

Repair Log

Unit Serial Number:
Institution Name:

Date	Maintenance/Repair	Technician

Unit Serial Number:
Institution Name:

Date	Maintenance/Repair	Technician

For your notes

5 Troubleshooting

For your notes

Terms Used

Listed and defined below are terms used in this chapter.

Abort (Main Code)

This is a Main Code menu selection that may appear on the monitor during software downloads from the monitor *SERVICE MODE* menu. ABORT causes the download to stop by pushing the **TRIM KNOB** control.

Boot Loader or Boot Code

The Boot Loader or Boot Code is used to download software. Entering the Boot Code does not erase any memory, but downloading new software will erase protected memory. To activate the Boot Code, perform the following.

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.

Cold Start

A cold start is used only in extreme circumstances. It erases the protected memory, language, unit name and bed number; automatically discharges the patient; and restores factory defaults. Ethernet address, internet address, software feature level, and CRG trend option remain unchanged.

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control and keep holding **NBP Go/Stop** and **Zero All**.
3. When the monitor resets and the display goes blank, press and hold **Display On/Off** (in addition to **NBP Go/Stop** and **Zero All**) until the message "*performing cold start*" appears on the display.

NOTE

If the Boot Code information appears before the message "*performing cold start*" appears, begin the cold start again.

Continue (Main Code)

CONTINUE is a Main Code menu selection that appears after a successful software download. It allows the user to continue downloading other files without resetting the monitor.

Monitor Memory

Monitor memory contains the Ethernet address, internet address, bed name, care unit name, and standard unit defaults for each monitor.

Protected Memory

Protected memory contains a patient's history and any individualized changes to the unit defaults.

Power Cycle or Reboot

To power cycle or reboot the monitor, turn the power OFF at the rear of the unit.

Service Mode (Main Code)

The *SERVICE MODE* menu is found in the monitor *MAIN* menu and is used for various functions like calibration, video tests, and downloading monitor interface software. (See details later in this chapter.)

Service Menu (Boot Code)

The Service Menu found in the Boot Code is used when downloading the Boot Code and main processor code. (See details later in this chapter.)

Warm Start (Boot Code)

A warm start activates the software previously downloaded. The following steps activates a warm start.

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *Start Patient Monitoring*.

Country Selection

This is a Boot Code setting. The choices are France, Germany, or Default which chooses a particular set of GE Medical Systems *Information Technologies* factory defaults. These defaults are used when changing the unit type (Adult-ICU, OR, or Neonatal).

Set Language

This is a Boot Code setting. It sets the language for displayed text in the Main Code. (Do not confuse with Country Selection.)

Service Menus (Boot Code)

The Boot Code *Service Menu* and Main Code *SERVICE MODE* menu are generally used by qualified field engineers and factory service personnel to troubleshoot, repair, or download new software to the patient monitor.

WARNING
The Boot Code service menu or *SERVICE MODE* menu is intended for qualified personnel only. It is possible to lose patient data, damage the operating software for this monitor, and even affect the Unity Network. Do not 'experiment' with any commands found in the service menus.

Boot Code *Service Menu*

Use the Boot Code service menu when downloading new Boot Code or Main Code software to the patient monitor or when the patient monitor exhibits a serious failure. Activate the Boot Code program as follows:

1. Hold down **NBP Go/Stop** and **Zero All** on the keypad or remote control.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *SERVICE MENU* from the *FILE SERVER SELECTION* menu to enter the Boot Code service menu.

Set up first Ethernet Port

This menu selection allows changes to the Ethernet address, gateway address, and internet mask.

WARNING
Duplication of an Ethernet address on a network causes data loss and possible Unity Network problems. If you change the factory assigned Ethernet address, you must record all other Ethernet addresses used on your network to avoid duplication.

Set up second Ethernet Port

Same as *Set up first Ethernet Port*.

Clear Monitor Memory

If you respond with *YES* in this option, you will erase all patient histories and programmed defaults in the protected memory and return to factory installed defaults.

Set Configuration

This menu contains options for defib sync for ECG modules (not Tram modules), line frequency, country selection (not for text translations), and setting language for displayed text.

WARNING
Changing the language will discharge the monitor and erase any saved monitor defaults. The monitor defaults will be set to the factory defaults.

Serial Download Main

This option is used when downloading software from a laptop PC.

Serial Download Boot

This option is used when downloading software from a laptop PC.

View Main Code Error Logs

Allows access to the error logs generated by the Main Code.

Tools Menu

This password protected menu contains service diagnostic tools. Use password "**mei^**".

Video Test Screens

Various color screens for testing the display.

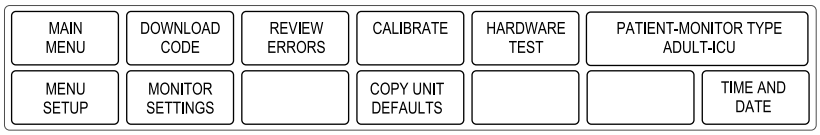
Options Menu

In this menu, you can enable various software options (Hires Trends, Cardiopulmonary Features, etc.) and change the monitor software level. A unique password is required for each option and to change the software level or Ethernet address. Fax a password request to GE Medical Systems Customer Relationship Center at (414) 362-3250 to obtain a password. You must provide your product serial number and Ethernet address. (The Ethernet address displays in the Boot Code banner information.)

Main Code *SERVICE MODE* Menu

Access the *SERVICE MODE* menu starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros. (e.g. July 4 = 0407).



DOWNLOAD CODE

This menu provides options for downloading ECG/RESP, SpO2, RAC COMM/ DAS, SAM, TIA, OCTANET, and CO2 modules.

REVIEW ERRORS

This menu selection is for advanced troubleshooting by GE Medical Systems *Information Technologies* engineers. Error log data can be transferred over the network to a central station and then loaded onto a diskette for review.

CALIBRATE

These menu selections are used to calibrate the touchscreen and various inputs from the Tram module or other discrete modules. Refer to the module service manual for details. See chapter 6, Configuration, for calibration details.

HARDWARE TEST

This menu provides access to the hardware tests for the monitor.

Hardware Status

The ‘one of a kind’ patient monitor LAN address is listed here. The current revision of the main processor and FPGA are also listed.

Video Test

WARNING
Loss of patient data. Do not enter this menu selection unless loss of patient data is not an issue.

Provides a list of various test patterns and colors that can be used to calibrate the display. When finished, select *RESTART System*.

PATIENT-MONITOR TYPE

Select the type of monitor desired, i.e., adult, neonatal or operating room. Refer to Chapter 6, Configuration, for detailed procedures.

WARNING
Changing the patient-monitor type will default the admit function to STANDARD configuration. Different alarms and parameters are activated for each selection.

NOTE
The keypad/remote control is DIDCA programmed for specific monitor types. The error message *WARNING: REMOTE MISMATCHED WITH MONITORING MODE* displays if the monitor and keypad/remote control do not match.

MENU SETUP

This menu selection provides the following submenus: (Refer to Chapter 6, Configuration, for detailed procedures.)

ADMIT MENU: STANDARD

This menu selection allows you to determine the function of the patient monitor. The four variables include stationary or ambulatory (telemetry) patient monitoring with a monitor that always stays in one room (*STANDARD*) or a monitor that moves from room to room (*ROVER*).

SOFTWARE LEVEL

This menu selection displays the software feature level this monitor is using. It allows setting the level to a lower setting than the software feature level setting in Boot Code.

MONITOR DEFAULTS PASSWD

This menu selection is used to turn a password requirement ON or OFF for entry into the *MONITOR DEFAULTS* menu section described above. If selected, the password will be the same as the *SERVICE MODE MENU* password.

MONITOR SETTINGS

This menu selection provides the following submenus: (Refer to Chapter 6, Configuration, for detailed procedures.)

SET UNIT NAME

This menu selection allows changes to the care unit name. After initial setup, this name should not be changed or communication to the central station will be corrupted. Note that the care unit name must be registered exactly the same in the central station and the patient monitor.

SET BED NUMBER

This menu selection allows changes to the bed number. After initial setup, this number should not be changed or communication to the central station will be corrupted. Note that the bed number must be registered exactly the same in the central station and the patient monitor.

SET LOCATION ID

Enter the location identification for the MUSE system.

SET SITE NUMBER

A site number may be necessary if your institution has multiple buildings. A MUSE system can be used as a site number.

STORE DEFAULTS FOR NETWORK TRANSFER

This menu selection saves the monitor defaults for transfer to another monitor with the same software, patient monitor type, and country code. It stores all monitor defaults, custom default names, and 12 SL location and site.

SET INTERNET ADDRESS

This menu selection allows changes to the internet (IP) address.

WARNING
Duplication of an internet (IP) address on a network causes lost data. If you change the factory assigned internet address, you must first record all other internet addresses used on your network to avoid duplication.

An incorrect internet address may also prevent the monitor from viewing other monitors on the network. Whether or not this can occur depends on the network topology at the installed site.

COPY UNIT DEFAULTS

This menu option is used to copy monitor defaults from one monitor to another monitor. Refer to Chapter 6, Configuration, for detailed procedures.

TIME AND DATE

This menu selection allows changes to the time and date and may affect the time and date for the entire monitoring network. Refer to Chapter 6, Configuration, for detailed procedures.

WARNING
Loss of patient history. This menu should rarely be used because patient histories will be lost.

General Fault Isolation

Visual Inspection

A thorough visual inspection of the equipment can save time. Small things—disconnected cables, foreign debris on circuit boards, missing hardware, loose components—can frequently cause symptoms and equipment failures that may appear to be unrelated and difficult to track.

The following steps might seem trivial but it is highly recommended that they be performed to remove these “simple” failures as causes of problems.

- Set the ON/OFF switch to the OFF position and disconnect the monitor from its power source.
- Read the “Disassembly Guidelines” in Chapter 7, Upper Level Assembly, before you perform an internal visual inspection of the components.

WARNING
Shock hazard. High voltages exist in this unit. Use insulated tools. Remove jewelry. Use only one hand when possible.

- Verify correct Ethernet and internet addresses.

Take the time to make all the recommended visual checks (refer to the visual inspection table below) before starting any detailed troubleshooting procedures.

Visual Inspection Table	
Area	Look for the following problems:
I/O Connectors and Interface Cables	■ Fraying or other damage ■ Bent prongs or pins ■ Cracked housing ■ Loose screws in plugs ■ Excessive cable tension or wear ■ Secure mounting hardware
Internal Harnesses and Cables	■ Excessive tension or wear ■ Loose connection ■ Strain reliefs out of place
Circuit Boards	■ Moisture, dust, or debris (top and bottom) ■ Loose or missing components ■ Burn damage or smell of overheated components ■ Socketed components not firmly seated ■ PCB not seated properly in edge connectors ■ Solder problems: cracks, splashes on board, incomplete feedthrough, prior modifications or repairs
Ground Wires/Wiring	■ Loose wires or ground strap connections ■ Faulty wiring ■ Wires pinched or in vulnerable position
Mounting Hardware	■ Loose or missing screws or other hardware, especially fasteners used as connections to ground planes on PCBs
Power Source	■ Faulty wiring, especially AC outlet ■ Circuit not dedicated to system (Power source problems can cause static discharge, resetting problems, and noise.)

Calibration

The Solar 8000M patient monitor is factory calibrated and requires no calibration in the field. The only field adjustable switch is S1 on the power supply. It selects the range for the AC mains input, but should not need to be changed.

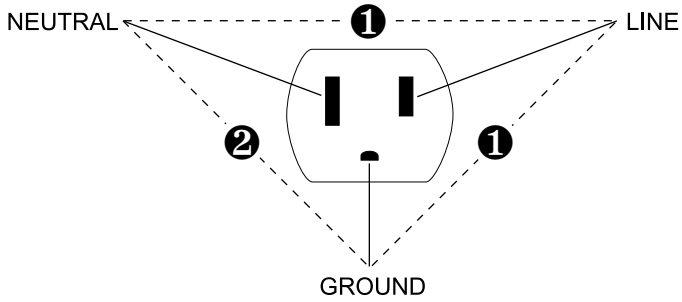
AC Line Voltage Test

This test verifies that the domestic wall outlet supplying power to the equipment is properly wired. For international wiring tests, refer to the internal standards agencies of that particular country.

120 VAC, 50/60 Hz

Use a digital voltmeter to check the voltages of the 120-volt AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

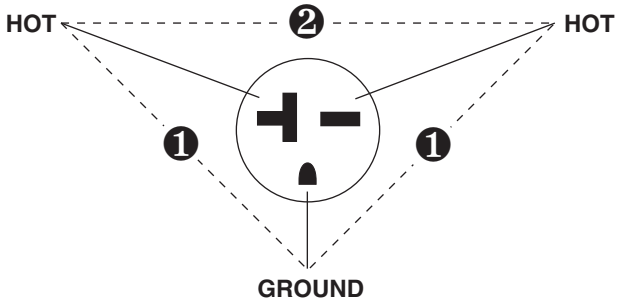
1. 120 VAC (± 10 VAC) between the line contact and neutral and between the line contact and ground.
2. Less than 3 VAC between neutral and ground.



240 VAC, 50/60 Hz

Use a digital voltmeter, set to measure at least 300 VAC, to check the voltages of the NEMA 6-20R, AC wall outlet (dedicated circuit recommended). If the measurements are significantly out of range, have a qualified electrician repair the outlet. The voltage measurements should be as follows:

1. 120 VAC (± 10 VAC) between either “hot” contact and ground.
2. 210 to 230 VAC between the two “hot” contacts.



Troubleshooting Procedure

Many network problems at the central station are traced back to the patient monitor or Tram-rac housing. Therefore, many of the troubleshooting suggestions in the "Problems and Solutions" section include replacing pcb assemblies in the patient monitor or Tram-rac housing. The "LED Troubleshooting Table" explains the normal condition of the various LEDs on the pcb assemblies.

Do not perform the procedures listed unless you are a trained field or biomedical engineer. Refer to "Theory of Operation" in Chapter 7 for circuit board functions. To aid in disassembly of the unit, refer to the "Disassembly Guidelines" in Chapter 7.

WARNING
Patient data loss. This procedure is intended for use by service personnel with advanced troubleshooting skills. The consequences of the following steps may cause loss of patient data and disruption of the entire Unity Network.

Before Replacing the Processor pcb

Before replacing the processor pcb, write down the following information: (All settings are viewable in Boot Code except for unit type. See "Boot Loader or Boot Code" on page 3 of this chapter.)

- Current language (set in Boot Code)
- Bed number (set in Main Code)
- Unit name (set in Main Code)
- Subnet masks 1 and 2 (set in Boot Code)
- Gateway addresses 1 and 2 (set in Boot Code)
- Internet (IP) addresses 1 and 2 (set in Boot Code)
- Product type (UnityView or Solar 8000M) (set in Boot Code)
- Line frequency (50/60 Hz) (set in Boot Code)
- Sync pulse height and width (set in Boot Code)
- Hi Res trends (enabled/disabled) (set in Boot Code)
- Software feature level (set in Boot Code)
- Country selection (set in Boot Code)
- Unit type (adult, OR, neonatal) (set in Main Code)

After Replacing the Processor pcb

1. After installing the new processor pcb, perform a cold start. (See “Cold Start” on page 3 of this chapter.) Visually verify that the “*performing cold start*” message appears to be sure the a cold start was actually performed.
2. Restore the above settings.
3. If the patient monitor is NOT on the Unity Network, be sure to set the time and date.

WARNING
Patient data loss. Do not change the time and date if the patient monitor is on a network. Doing so will result in patient data loss.

If the monitor is on a network, verify that the time and date is automatically set by the network time master.

Problems and Solutions

Problem	Possible Reason/Solution
The display is blank.	The video display has no power. Verify that the display's power indicator is illuminated. The patient monitor has no power. Verify that the patient monitor's power indicator is illuminated. The video display is not properly connected to the patient monitor. Verify that the correct cable connects the video display to one of the 4 video ports on the patient monitor. The display was turned off via the **Display On/Off** button on the keypad/remote control. Press the **Display On/Off** button on the keypad/remote control. Hardware failure. 1. The SDRAM test performed by Boot Code failed.Check the LS6 LED (I'm OK). If the SDRAM test failed, it will continually flash error codes. ■ Error codes always start with 3 very short pulses in quick succession. ■ Binary 1s are long ON pulses. ■ Binary 0s are short ON pulses. ■ The first digit is the most significant. ■ There are 6 binary digits per error code. ■ A short pause occurs between the first 4 binary digits and the last 2 binary digits. If you observe error codes, replace the processor pcb. 2. Boot Code not loaded properly or is corrupt. This may be the case if the I'm OK LED is stuck ON or OFF. Replace the processor pcb. 3. Power supply failure. Replace the power supply. 4. Loose connections to power supply. Tighten connections. 5. Excessive loading on external connector due to malfunctioning peripheral device. Isolate and replace the malfunctioning device. 6. Other. Replace the power supply. 7. Power supply replaced, but display still doesn't work. Replace processor pcb.
Boot Code starts, but Main Code does not.	1. Check the boot banner for hardware test results. The following information is available: ■ SRAM test results (passed or failed) ■ SDRAM test results (passed or failed) ■ Main flash check (passed or failed) ■ Boot flash check (passed or failed) ■ Real time clock (is running or failed) If any of the above is failed, then Boot Code refuses to run the Main Code. Cycle power on the patient monitor and it may correct itself. If the problem persists, download Boot Code and Main Code. If the problem is still not corrected, replace the processor pcb. 2. Attempt to start Main Code via the "return to Patient Monitoring". One of the following may be the problem: ■ Main Code not loaded. Follow the directions in the Solar 8000M Patient Monitor Software Installation Instructions to download Main Code. ■ Main Code and Boot Code not compatible. Follow the directions in the Solar 8000M Patient Monitor Software Installation Instructions to update the Boot Code to a version compatible with the Main Code.
The quality of the display is not good.	Check the connection between the video display and the patient monitor and correct, if necessary, or replace the video display with a known good one. If the problem is not corrected, replace the processor pcb.

Problem	Possible Reason/Solution
Patient data does not display.	1. Verify correct patient or simulator leadwire connections to the Tram module in Tram-rac housing. 2. Verify that the Tram module is completely inserted and ON. 3. Verify that the Tram-rac housing is turned ON. 4. Select the *SOFTWARE REVISION* menu and verify that the *RAC COMM*, *RAC DAS*, or *TRAM MODULE* software file numbers are there. ■ If *INCOMPATIBLE SOFTWARE REV* message displays, refer to "Software Updating" in Chapter 6, "Configuration." ■ Check for a loose or faulty cable from the patient monitor to the Tram-rac housing. ■ Cycle power to the Tram-rac housing. ■ View error logs for TRAM module and patient monitor. Refer to "Reviewing Errors Logs" in Chapter 6, "Configuration." ■ Replace Tram module with a known good one. ■ Replace Tram-rac housing with a known good one.
Patient alarms are not sounding when activated.	1. If a patient's waveform and the *DISCHARGED* message both display, consult the operator's manual for correct patient admitting instructions. The alarm function remains disabled until the patient is correctly admitted into the system. 2. Make sure the alarms are enabled. Consult the operator's manual for correct alarm settings. 3. Verify that the alarm volume is not turned off. Look in *ALARM CONTROL -> ALARM VOL:* 4. Test if the speaker is functioning, using the *LEARN THE MONITOR* menu option.
Patient alarms are not sounding at the desired central station.	The alarm function remains disabled until the patient is correctly admitted into the system. 1. If *DISCHARGED* message displays, consult the operator's manual for correct patient admitting instructions. 2. If the monitor was moved from one care unit to another, reprogram the alarm destinations. ■ Watch for misspelling or spaces in the name. ■ Make sure that the care unit name programmed into the monitor and central station match exactly. Typically, the care unit name for a monitor is not shown on the central station display of a patient's data. Only the bed number is shown. If the care unit name for a monitor does not match the central station care unit name, then the monitor identification changes. The monitor identifier shows the care unit name followed by a vertical slash (|) and then the bed number. The solution is to modify the monitor care unit name to match the central station's care unit name. 3. Force an alarm from another monitor to test if the speaker is functioning.
Waveforms displayed at the central station are incomplete.	1. Make sure all SQE (signal quality enable) switches are turned OFF for all transceivers. 2. Use *LANSTATS* function in the *SERVICE MONITOR* of the central station to get the LAN statistics. Refer to Troubleshooting in the Centralscope Central Station Service Manual for more information. 3. Check for large amounts of data errors at each central station in the system. ■ If only one central station has a large number of detected errors, this implies a problem with that specific central station. Try replacing the LAN controller pcb in the central station. ■ If large error values are found in all central stations in the system, there may be a problem with the Unity Network. Try troubleshooting the network for loose connections and faulty transceivers.

Problem	Possible Reason/Solution
Patient data from the Solar 8000M does not display at the central station.	Determine if all, multiple, or one patient monitor is not communicating with the central station. 1. If the central station displays a *NO COMM* message for ALL patients, do the following: ■ Cycle power at the central station. ■ Verify that the central station is programmed to display the patient data. Use *SELECT BEDS FOR DISPLAY AT THIS CENTRAL* option. ■ Verify that the care unit name is correctly programmed in the central station. Refer to the Centralscope Central Station Service Manual for instructions. ■ Use the *SERVICE MONITOR* menu of the central station to check if the patient monitor is communicating with the network. The *LIST NETWORK* option shows all monitors actively communicating. If no patient monitors are listed but the central station is listed, do the following: ■ Check for a loose connection between the central station and the transceiver. ■ Check for a faulty transceiver. ■ Check for an open transceiver cable connection. ■ Check for loose or faulty Ethernet cabling. ■ Verify proper Ethernet and internet addresses on both the central station and the patient monitor. Replace the LAN controller or processor pcb in the central station with a known good one. 2. If the central station displays a *NO COMM* message for multiple, but not all patients, do the following: ■ Cycle power to the central station. ■ Use the *SERVICE MONITOR* menu of the central station to check if the patient monitor is communicating with the network. The *LIST NETWORK* option shows all monitors that are actively communicating. Refer to the Centralscope Central Station Service Manual for details. ■ If all patient monitors are listed correctly, check the configuration of the patient monitors that are not communicating. Refer to “Configuring the Monitor” in Chapter 6, “Configuration.” ■ If some patient monitors are not in the network list, check the overall topology of the network to locate the segment not communicating. ■ Check for loose connections. ■ Check transceivers and interface cables to the Ethernet cables.
Patient data from the Solar 8000M does not display at the central station. (Continued)	1. If the central station displays a *NO COMM* message for one patient, do the following: ■ Cycle power to the Solar 8000M processing unit. ■ Cycle power to the central station. ■ Check for a loose connection between the patient monitor and the Ethernet cable. ■ View error logs for *TRAM* and the monitor. Refer to “Reviewing Errors Logs” in Chapter 6, “Configuration.” ■ An incorrect LAN address was programmed into the monitor. Refer to “Configuring the Monitor” in Chapter 6, “Configuration.” ■ Verify that there is no duplication of internet (IP) and LAN addresses on the network. ■ Verify operation of the processor pcb with the “LED Troubleshooting Table.”

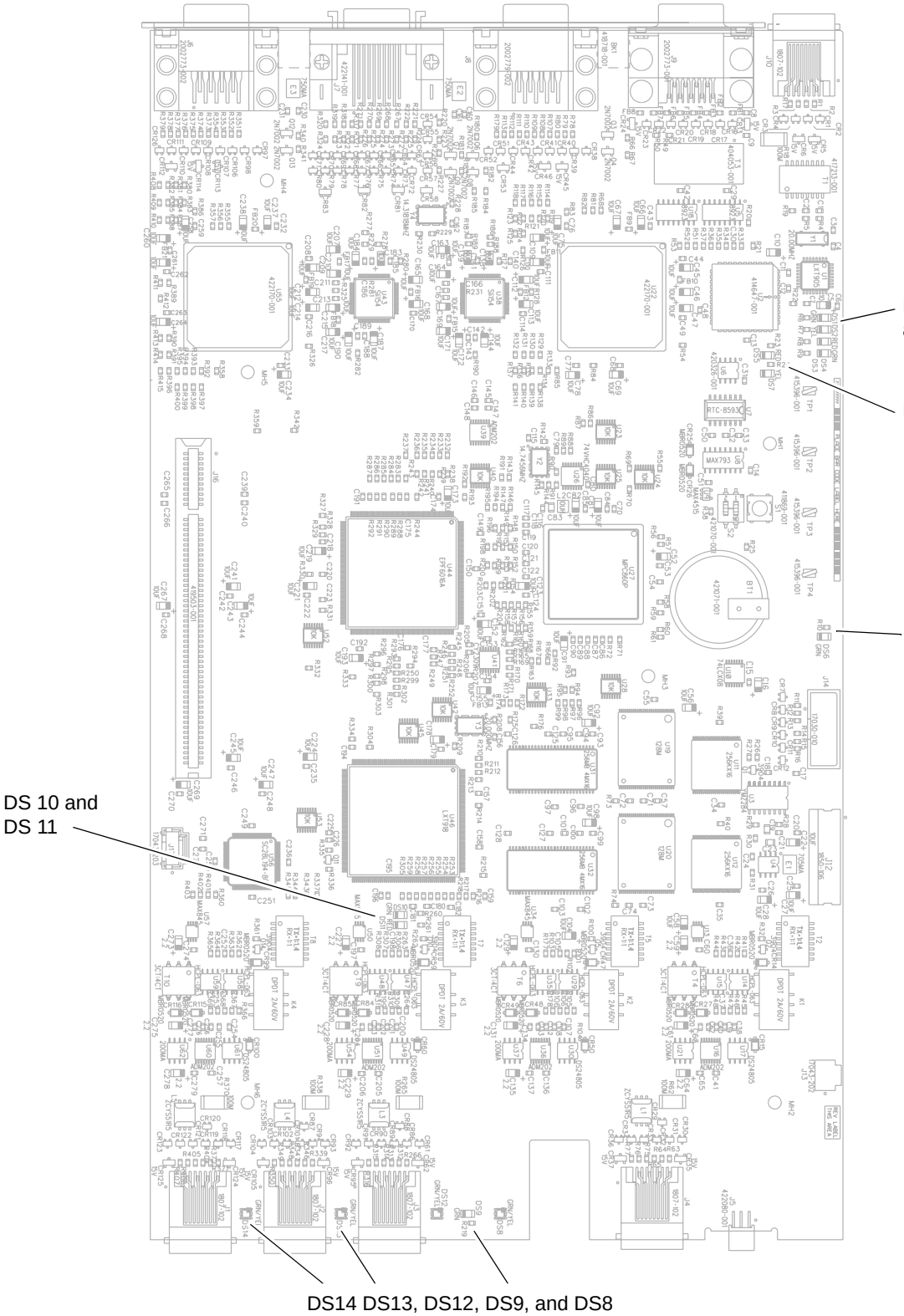
Problem	Possible Reason/Solution
Graphs and alarms are not printed at the desired location.	1. Verify paper in central station writer is correct side up. 2. If the monitor was moved from one care unit to another, reprogram the graph destinations. ■ Watch for misspelling or spaces in the name. ■ Make sure that the care unit name programmed into the monitor and central station match exactly. Typically, the care unit name for a monitor is not shown on the central station display of a patient's data. Only the bed number is shown. If the care unit name for a monitor does not match the central station care unit name, then the monitor identification changes. The monitor identifier shows the care unit name followed by a vertical slash (|) and then the bed number. The solution is to modify the monitor care unit name to match the central station's care unit name.
The remote control does not activate the display.	This is caused by an interruption of power to the remote control. 1. Check the M-Port LED. If it is illuminated, the remote is communicating with the patient monitor. 2. Check for a loose connection from the monitor to the remote control. 3. Try a different M-port. 4. Disconnect and securely reconnect the remote control from the monitor to reset the remote control. 5. Replace remote control with a known good one. 6. Replace processor pcb in patient monitor with a known good one.

LED Troubleshooting

The following table describes the function and normal condition of the patient monitor LEDs to aid in troubleshooting.

LED/Color	Signal Name	Function	Normal Condition
Tram-net LEDs on Processor PCB			
DS7/Yellow	Network Activity	"I hear all talking on Tram-net"	ON steady or flickers
DS5/Red	Jabber Detect	"I detect excessive talking on Tram-net"	OFF if all hub ports OK
Unity Ethernet LEDs on Processor PCB			
DS1/Green	Transmit	"I am talking on Ethernet"	Flashes when transmitting
DS2/Yellow	Receive	"I am listening to Ethernet."	Flashes when receiving
DS3/Red	Collision Detect	"I detect collisions on Ethernet."	ON when detecting collision
DS4/Green	Link	"I hear all talking on Ethernet."	ON when receive path is OK from hub to the Solar 8000M
M-Port Ethernet LEDs on Processor PCB			
DS10/Green	Transmit Enable	"I am talking on Ethernet."	Flashes when transmitting
DS11/Red	Collision Detect	"I detect collisions on Ethernet."	ON when detecting collision
Processor LEDs on Processor PCB			
DS9/Green	Power	"+3.3V is applied to PCB."	ON steady
DS6/Green	"I am OK LED"	"Main processor PCB is OK."	Flashes at ≈ 1-2 Hz
Tram-net LEDs on Tram-rac Processor PCB in the Tram-rac Housing			
DS1/Green	Power	"+5V is OK to PCB"	ON steady
DS2/Red	Network Activity	"I hear all talking on Tram-net"	ON mostly steady with Tram-rac connected or flickers LOW with no Tram-rac connected
DS3/Green	Transmit Enable	"I am talking on Tram-net"	Flickers ON with red LED[1] ON steady while graphing
DS4/Yellow	Error Detect	"I detect an error on this PCB"	OFF
DS6/Red	Rac COMM	"Tram-rac 4 processor PCB is OK"	Flashes opposite DS5 (twice per second)
DS5/Red	Rac DAS	"Data acquisition PCB is OK"	Flashes opposite DS6 (twice per second)

1. Because "I hear when I am talking," the "talking" LED flashes with the "hearing" LED, but the "hearing" LED will also flash alone when it "hears someone else talking."


DS1, DS2, DS3, and DS4
DS5 and DS7
DS 6
DS 10 and DS 11
DS14 DS13, DS12, DS9, and DS8

M-Port Status LEDs DS14, DS13, DS12, DS8 on Processor PCB	
State	Description
Solid green	Indicates the device is communicating properly.
Slow flashing yellow	Indicates the device has been identified, but there is no communication.
Flashing yellow	Indicates that too many identical devices are connected or the device cannot be identified.

Troubleshooting Software Updates - Problems and Solutions

The following is a list of problems commonly encountered during a software update with their solutions.

Problem	Possible Reason/Solution
Monitor appears 'locked up' during a network download.	**CAUTION** Do not power cycle or reboot the monitor if downloading the Boot Code is proceeding normally. The monitor will be rendered useless. If the packet or byte numbers stop advancing for at least two minutes, do the following: 1. Check that all cables are properly connected. 2. At the patient monitor: ■ Hold down NBP Go/Stop and Zero All. ■ Press and release the TRIM KNOB control. ■ Keep holding NBP Go/Stop and Zero All until the Boot Code information appears on the display. 3. Repeat the software update procedure for the aborted file from the beginning.
Software revision window does not list part numbers.	If the part numbers are not listed for the monitor interfaces in the software revision window, the software update has not been activated. Power cycle the monitor and view the software revisions window again. If the part numbers are still missing, repeat the update procedure for each missing file.
Waveforms do not appear at the central station.	If communication is corrupted, do the following: 1. Check all cables for a good connection. 2. Ensure that the central station software is correct. 3. Ensure Ethernet addresses have been programed correctly. Refer to the appropriate service manual. 4. Ensure the Ethernet address has been programmed correctly at the patient monitor: ■ Hold down NBP Go/Stop and Zero All. ■ Press and release the TRIM KNOB control. ■ Keep holding NBP Go/Stop and Zero All until the Boot Code information appears on the display. ■ The Ethernet address displays in the Boot Code banner information. 5. If the Ethernet address needs to be changed in Boot Code, a unique password is required to access *Change Ethernet Address* in the *Options Menu*. Fax a password request to GE Medical Systems *Information Technologies* Customer Relationship Center at 877-633-8181 to obtain a password. You will need to provide your product serial number and Ethernet address. (The Ethernet address displays in the Boot Code banner information.)

Error Messages

The following table describes error messages that may appear on the display and how to resolve the problem.

Message	Possible Reason/Solution
"WARNING: The EEPROM data was found to be either INVALID or uninitialized. GE Medical Systems *Information Technologies* factory defaults will be stored in both the EEPROM and the monitor's configuration memory. You will be required to re-enter the network configuration, re-enable any password protected features and restore all monitor settings and site-specific defaults."	Following the EEPROM dump, restore data: 1. Restore Ethernet address and IP address as requested by the Boot Code. 2. Power cycle. 3. If error message persists, replace processor pcb. If error message no longer occurs, re-enable any password protected features and restore all monitor settings and site-specific defaults via *SERVICE MENU -> Set Configuration*, and *Options Menu*.
"ERROR: THE INTERNAL BATTERY THAT MAINTAINS THE MONITOR'S DEFAULTS HAS FAILED!" * * SERVICE MAY BE REQUIRED * *	Check switch S2-2. Battery may be depleted. Replace the processor pcb. (See chapter 7, Upper Level Assembly, Disassembly Guidelines for the Processor Board.)
"WARNING: The last attempt to load Main Code failed. The checksum calculated for the SDRAM did not match what was expected. If this problem occurs repeatedly, your monitor may need to be serviced."	1. Power cycle. 2. If problems persists, replace processor pcb.
"WARNING: THIS VERSION OF BOOT CODE IS NOT COMPATIBLE WITH THE VERSION OF MAIN CODE CURRENTLY STORED IN FLASH. PLEASE UPDATE THE BOOT CODE."	1. Power cycle. 2. Reload Boot Code. 3. If problems persists, replace processor pcb.
"Boot Flash test FAILED." "ERROR: The Boot Code stored in Flash is not valid. Main Code cannot be loaded until valid Boot Code exists."	1. Power cycle. 2. Reload Boot Code. 3. If problems persists, replace processor pcb.
"Main Flash test FAILED." "ERROR: The Main Code stored in flash is not valid."	1. Power cycle. 2. Reload Main Code. 3. If problems persists, replace processor pcb.
"Main Code SDRAM FAILED. " "ERROR: The region of SDRAM reserved for Main Code failed the memory test. Main Code will not be loaded unless this test passes. Reboot the monitor to repeat testing."	Replace processor pcb.
"Static RAM test FAILED." "ERROR: The SRAM memory test failed. Main Code will not be loaded unless this test passes. Reboot the monitor to repeat testing."	Replace processor pcb.

Message	Possible Reason/Solution
"Real Time Clock FAILED - will not start." "WARNING: The real time clock chip is not running. Main Code cannot be loaded until this chip is started. Attempting to start real time clock..." Followed by either "The real time clock was started. Select Start Patient Monitoring to load and execute Main Code." Or "ERROR: Unable to start the real time clock."	If problem persists and error message displays, replace processor pcb.
"EC1" (displayed to the left of the ECG parameter block)	Perform all of the maintenance procedures listed in the "Manufacturer Recommendations" section of Chapter 4, Maintenance.

For your notes

6 Configuration

For your notes

Configuring a Monitor

The following procedure explains how to configure a patient monitor on the Unity Network. The monitor communicates with central stations, and other related equipment over the Unity Network. This network is essentially an Ethernet implementation.

General

Use this procedure if you are:

- experiencing communication problems on the Unity Network, or
- adding a new monitor to the Unity Network.

Gather Information

To configure a new monitor, you must first:

- know that the new monitor's software revision is compatible with the other monitors connected to the Unity Network.
- write down the exact care unit name from the upper left hand corner of the central station.
- write down the bed name for the new monitor.
- know if the monitor will be used for either stationary or ambulatory (telemetry) monitoring or both.
- know if the monitor will be moved from one Ethernet connection to another.

Select Procedures

Choose and program the procedures listed below in the order presented. Each procedure is described on the next pages.

- Set Unit Name (Main Code)
- Set Bed Number (Main Code)
- Patient-Monitor Type (Main Code)
- Set Graph Locations
- Admit Menu (Main Code)
- Set Line Frequency (optional, Boot Code)
- Set Defib Sync Voltage and Pulse Width (optional, Boot Code)
- Set Country Selection (Boot Code)
- Set Language (Boot Code)
- Calibrate Touchscreen

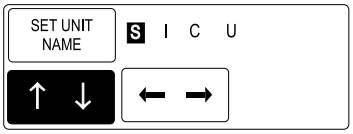
After completing all necessary procedures, perform the "Checkout Procedure" found in Chapter 4, Maintenance.

Set Unit Name

Up to seven characters are used to identify the care unit. These characters display at the top right of the screen immediately preceding the bed number.

Access *SET UNIT NAME* option, starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *MONITOR SETTINGS -> UNIT NAME.*



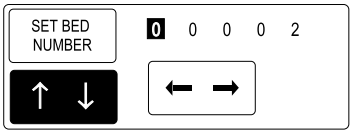
4. Use the **TRIM KNOB** control to select and change each character. Up to seven characters may be entered.
5. Select *SET UNIT NAME* and press the **TRIM KNOB** control to exit.

Set Bed Number

The bed number identifies a particular patient bed. Up to five characters are used to identify bed number. This number displays at the top right of the screen.

Access *SET BED NUMBER* option, starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *MONITOR SETTINGS -> UNIT NAME -> SET BED NUMBER.*



4. Use the **TRIM KNOB** control to select and change each character. Up to five characters may be entered.
5. Select *SET BED NUMBER* and press the **TRIM KNOB** control to exit.

Patient-Monitor Type

The *PATIENT-MONITOR TYPE* selection determines the type of monitor desired, i.e., adult, neonatal or operating room. Different alarms and parameters are activated for each selection. This menu item is part of the *SERVICE MODE* menu.

CAUTION

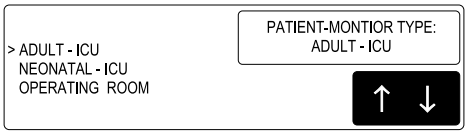
Each time the patient-monitor type is changed, the *ADMIT MENU* function defaults to *STANDARD* configuration. Be aware that some alarms and parameters may be changed.

NOTE

The keypad/remote control is DIDCA programmed for specific monitor types. The error message *WARNING: REMOTE MISMATCHED WITH MONITORING MODE* displays if the monitor and keypad/remote control do not match.

Access *PATIENT-MONITOR TYPE* option, starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *PATIENT-MONITOR TYPE*. Be sure to read the information in the ATTENTION box before changing anything.



4. Rotate **TRIM KNOB** control to select the type of environment the monitor will be used in.
5. Press **TRIM KNOB** control to exit. Your selection displays at the top of the screen after the time.

Set Graph Locations

Access *MANUAL GRAPH LOCATION* option, starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> GRAPH SETUP -> GRAPH LOCATION -> MANUAL GRAPH LOCATION*.
2. Using the **TRIM KNOB** control, choose the manual graph location from the list.
3. Select *ALARM GRAPH LOCATION*.
4. Using the **TRIM KNOB** control, choose the alarm graph location from the list.
5. Select *PRINT WINDOW LOCATION*.
6. Using the **TRIM KNOB** control, choose the print window location from the list.
7. Select *12 LEAD PRINT LOCATION*.
8. Using the **TRIM KNOB** control, choose the 12 lead print location from the list.

Communication Confirmation

Confirm communication across the network.

1. Admit and generate a waveform at the monitor with a simulator.
2. Press **Graph Go/Stop** and observe graph output at chosen locations.

Problems?

If the writer or printer does not graph:

- Ensure the writer or printer is turned ON.
- Check all cables for a good connection.
- Check programmed alarms and manual graph locations at the monitor.

If you do not have a waveform at the central station:

- Ensure the central station software is compatible.
- Check all cables for a good connection.
- Check the programmed alarms and manual graph locations at the monitor.
- Ensure the care unit name is the same in the monitor and in the central station.
- Ensure the central station serial number and LAN address are programmed correctly.

Admit Menu

The *ADMIT MENU* selection determines the function of the monitor. This menu item is part of the *SERVICE MODE* menu.

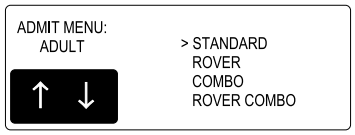
Before programming the *ADMIT MENU*, you must know if the monitor will be used for standard adult, neonatal, or operating room monitoring, and if the monitor will be moved from room to room. All combinations are explained below.

- STANDARD configures the monitor to stay in one room for stationary

monitoring only. Monitors not connected to the Unity network (Ethernet connection) must use STANDARD configuration only.

- ROVER configures the monitor to move from room to room for stationary monitoring only.
- COMBO configures the monitor to stay in one room for both stationary and ambulatory (telemetry) monitoring. This monitor displays all Tram module data combined with ECG data for ambulatory patients.
- ROVER COMBO configures the monitor to move from room to room for both stationary and ambulatory (telemetry) monitoring.

1. Access *ADMIT MENU* option, starting from the MAIN menu. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *MENU SETUP -> ADMIT MENU.*



4. Use the **TRIM KNOB** control to select the function of the monitor.
5. Press **TRIM KNOB** control to exit.

Set Line Frequency

Use the Boot Code *SERVICE MENU* to configure or change the monitor line frequency to 50 or 60 Hz. The default is 60 Hz.

Activate the Boot Code:

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *SERVICE MENU*.
5. Select *4 SET CONFIGURATION* menu option.
6. In the *Configuration Menu*, select *Line Frequency* then choose 50 Hz or 60 Hz line frequency.

Set Defib Sync Voltage and Pulse Width

The Solar 8000M patient monitor controls the analog out signal used to trigger a defibrillator. Refer to the defibrillator manufacturer's manual for the required pulse amplitude and duration.

Use the Boot Code *SERVICE MENU* to configure or change the MARKER OUT signal of the DEFIB SYNC connector on a Solar ECG module.

Activate the Boot Code:

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *SERVICE MENU*.
5. Select *4 SET CONFIGURATION* menu option.
6. In the *Configuration Menu*, select:
   - *1 Defib Sync Voltage:* and choose 5V or 12V amplitude.
   - *2 Defib Sync Pulse Width:* and choose 10 ms or 100 ms for pulse duration.

Set Country Selection

Select *DEFAULT*, *FRANCE*, or *GERMANY* to choose a particular set of GE Medical Systems *Information Technologies* factory defaults.

Activate the Boot Code:

1. Hold down **NBP Go/Stop** and **Zero All**.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *SERVICE MENU*.
5. Select *4 SET CONFIGURATION* menu option.
6. In the *Configuration Menu*, select *4 Country Selection* and choose the desired set of factory defaults.

Set Language

Follow the steps for Set Country Selection above, except in the *Configuration Menu*, select 5 *Set Language* and select the desired language.

WARNING
Changing the language will discharge the monitor and erase any saved monitor defaults. The monitor defaults will be set to the factory defaults.

Calibrate Touchscreen

Access the *CALIBRATE TOUCHSCREEN* option, starting from the MAIN menu.

1. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE*.
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *CALIBRATE.*
4. Select *CALIBRATE TOUCHSCREEN*.
5. Touch and hold each of the 4 Xs as they appear per on-screen instructions.

Completion

The monitor is now ready for normal operation. At this time, perform the “Checkout Procedure” found in Chapter 3, Maintenance.

Advanced User Procedures

The following procedures are for advanced users only. These procedures should rarely be used, and only experienced technicians should proceed.

Procedures

The following procedures are discussed in this chapter.

- Set Time and Date
- Change Software Level
- Transfer Monitor Defaults
- Change Ethernet Address
- Set Internet Address
- Reviewing Error/Event Logs
- Transferring Error Logs

After completing any of the procedures, it is recommended to perform the "Checkout Procedure" found in Chapter 3, Maintenance.

Set Time and Date

Change the time only when the system is switched to or from daylight savings time.

NOTE

When a monitor is first connected to the Unity Network, the time and date is automatically updated from the network time.

WARNING

Loss of patient data history. Changing the time or date settings may result in the loss of patient data history. If one monitor's time or date is changed, all monitors on the network 'listen' and follow suit within 3-5 seconds. Changing the time base of one monitor may cause some loss of patient data history for all the monitors on the network.

The following procedure explains how to use the *TIME AND DATE* option in the monitor *SERVICE MODE* menu.

1. Access the *TIME AND DATE* menu starting from the MAIN menu. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).

Set Time

3. Select *SET TIME* and use the **TRIM KNOB** control to change the time. The time displays as a 24-hour military clock.

Set Date

4. Select *SET DATE* and use the **TRIM KNOB** control to change the date.

Change Software Level

Lower Level

The highest software feature level (Basic, Cardiac) of the patient monitor is programmed into the serial EEPROM of the processor PCB. You may only change the feature level to a lower level than the level programmed at the factory through the Main Code.

1. Access the *SOFTWARE LEVEL* option starting from the MAIN menu.Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *MENU SETUP -> SOFTWARE LEVEL.*
4. Use the **TRIM KNOB** control to select the software level.
5. Press the **TRIM KNOB** control to exit. Your selection displays at the top of the screen following the time.

Higher Level

If you want to change the software to a higher level or add software options, it must be done in Boot Code using a unique password.

Fax a password request to GE Medical Systems *Information Technologies* Customer Relationship Center at (414) 362-3250 to obtain a password. You must provide your product serial number and Ethernet address. (The Ethernet address displays in the Boot Code banner information.)

Activate the Boot Code program as follows:

1. Hold down **NBP Go/Stop** and **Zero All** on the keypad or remote control.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *Service Menu -> Option Menu -> Change Software Level.*

Enable Options

For information about enabling software options such as Hires Trends, Cardiopulmonary Features, etc., refer to the Solar 8000M Patient Monitor Enable Software Instructions, pn 2000701-104.

Transfer Monitor Defaults

The monitor defaults set on one monitor may be transferred to another monitor, provided that the second monitor shares the following:

- the same software revision (version),
- the same patient-monitor type (i.e., ADULT, NEO, or OR),
- the same software package (i.e., Basic or Cardiac), and
- the same country code (i.e. DEFAULT, FRANCE, or GERMANY).

The following defaults transfer when using this feature:

- all monitor defaults
- custom default names
- 12 SL location
- 12 SL site

Store Monitor Defaults for Transfer

To transfer monitor defaults, they must be set, then stored on the monitor that is used as the server.

1. At the server monitor, set up the monitor defaults you want to store. (Refer to Monitor Setup in the Solar 8000M Operator's Manual.)
2. When defaults are set, start from the MAIN menu and select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE*.
3. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
4. Select *MONITOR SETTINGS*.
5. Select *STORE DEFAULTS FOR NETWORK TRANSFER*
6. Selects *YES* to the confirmation popup menu.

Copy Stored Monitor Defaults

WARNING
Loss of Defaults. Copying monitor defaults from another monitor erases all of the monitor defaults on the current monitor.

To copy monitor defaults from the server monitor, the client monitor must be in the DISCHARGED state. If the client monitor is set to the OR patient-monitor type, it must not be in COMBO or ROVER COMBO admit mode.

NOTE
Make sure that the client monitor shares the same configuration as the server monitor.

1. At the client monitor, start from the MAIN menu and select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE*.
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *COPY UNIT DEFAULTS*.
4. Select *SELECT UNIT TO COPY MONITOR DEFAULTS FROM*.
5. From the list of units on the Unity Network, choose the server monitor.
6. Select *SELECT BED TO COPY MONITOR DEFAULTS FROM*.
7. Scroll through the list of beds within the selected unit until the desired bed is found. Select it, and answer *YES* to the confirmation popup menu.

NOTE
After transferring monitor defaults, the first set of defaults is automatically activated. If another set of defaults is desired, the user must manually select it from the *RECALL DEFAULTS* menu.

After copying monitor defaults from another bed (the server monitor), verify that the defaults were transferred and arrhythmia levels are as desired.

Troubleshooting Monitor Defaults Transfer

Below is a list of error messages that may display when performing a monitor default transfer.

Storing Monitor Defaults

Message	Description
ERROR - UNIT DEFAULTS HAVE NOT BEEN SAVED	Monitor defaults were not saved due to a memory error in the monitor.

Copying Stored Monitor Defaults

Message	Description
ERROR COPYING UNIT DEFAULTS - NETWORK ERROR	Either an error has occurred while the defaults were being transferred, or defaults have not been saved on the server monitor.
ERROR COPYING UNIT DEFAULTS - UNIT TYPE MISMATCH	The server and client monitors are set to different unit types (i.e., ADULT, NEO, or OR)
ERROR COPYING UNIT DEFAULTS - SOFTWARE VERSION MISMATCH	The server and client monitors have either different revisions of software, or different software versions (i.e., Solar 7/8000 vs. Solar 8000M)
ERROR COPYING UNIT DEFAULTS - DATA CORRUPTION ERROR	The monitor defaults transferred have become corrupted, possibly due to a memory error.
ERROR COPYING UNIT DEFAULTS - SOFTWARE FEATURE MISMATCH	The server and client monitors are set to different software levels (i.e., Basic, Cardiac).
ERROR COPYING UNIT DEFAULTS - COUNTRY CODE MISMATCH	The server and client monitors are set to different country codes (i.e., *DEFAULT*, *FRANCE*, or *GERMANY*).

Change Ethernet Address

The Ethernet address is an identification number assigned to each device on the Unity Network. It must be done in Boot Code using a unique password only if it has been corrupted.

WARNING
Lost Data. Duplication of an Ethernet address on a network will cause lost data. If you change the factory assigned Ethernet address, you must first record all OTHER Ethernet addresses used on your network to avoid duplication.

Fax a password request to GE Medical Systems *Information Technologies* Customer Relationship Center at 877-633-8181 to obtain a password. You must provide your product serial number and Ethernet address. (The Ethernet address displays in the Boot Code banner information.)

Activate the Boot Code program as follows:

1. Hold down **NBP Go/Stop** and **Zero All** on the keypad or remote control.
2. Press and release the **TRIM KNOB** control.
3. Keep holding **NBP Go/Stop** and **Zero All** until the Boot Code information appears on the display.
4. Select *Service Menu -> Option Menu -> Change Ethernet Address*.

Set Internet Address

The internet (IP) address is generated to connect Unity devices for the exchange of patient data and room-to-room communication. It may be manually derived from the monitor Ethernet address in this procedure if the factory-assigned internet address is corrupted.

NOTE

GE Medical Systems *Information Technologies* highly recommends using a 'private' LAN to connect Unity products. The purpose of the Unity Network is to connect only Unity devices for the exchange of patient data and room-to-room communication. Adding non-Unity devices (PCs, laptops, desktops, etc.) may compromise the ability of the Unity Network to meet its intended use.

A 'private' LAN is not the same as a private IP address.

WARNING

Lost Data. Duplication of an internet (IP) address on a network will cause lost data. If you change the factory assigned internet address, you must first record all *other* internet addresses used on your network to avoid duplication.

Valid and Invalid IP Addresses

Class A, Class B and Class C IP addresses are valid. Class D and Class E are invalid.

Class A =	0-127.x.x.x	OK
Class B =	128-191.x.x.x	OK
Class C =	192-233.x.x.x	OK
Class D =	234-239.x.x.x	Invalid
Class E =	240-255.x.x.x	Invalid

If using a Class A address, then all other octets (.x) can be any value.

If using a Class B address then all monitors that need to communicate with each other must have the same first TWO octets. For example:

130.1.1.2	OK
130.1.3.4	OK
130.1.5.6	OK
130.2.7.8	won't see other beds

If using a Class C address then all monitors that need to communicate with each other must have the same first THREE octets. For example:

192.1.2.1	OK
192.1.2.2	OK
192.1.2.3	OK
192.2.2.4	won't see other beds

Calculate Internet Address

To generate an internet address from an Ethernet address, GE Medical Systems *Information Technologies* simply converts the last three bytes of the Ethernet address from hex to decimal. This combines the unique identifier along with the network ID to produce the entire internet address.

Calculate the factory-assigned internet (IP) address as follows.

1. Write down the LAST SIX digits of the 12-digit monitor Ethernet address. (The Ethernet address displays in the Boot Code banner information.) An example is given below.

   00 : 00 : 7E : 26 : 13 : FD

2. Consider the six digits as three separate hexadecimal pairs. Convert each hexadecimal pair separately to a decimal number. All internet addresses must be in decimal.
3. The first number of the internet address is always 126 (decimal). The low three hex pairs of the IP address are the low three Ethernet address hex pairs converted to decimal.

   126 . 38 . 19 . 253

Enter Internet Address

Use the monitor *SERVICE MODE* menu in Main Code.

1. Access the *SET INTERNET ADDRESS* option starting from the MAIN menu. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *MONITOR SETTINGS-> SET INTERNET ADDRESS.*
4. Use the **TRIM KNOB** control to enter the correct digits.
5. Press the **TRIM KNOB** control to exit.

Power Cycle

Power cycle the monitor by turning the rear power switch OFF and then ON. This configures the monitor with the new programmed data.

Reviewing Error/Event Logs

This procedure describes how to review the error logs of a monitor or Tram module. The error logs may also be transferred over the network to a central station and copied onto diskette for further review or sent to GE Medical Systems *Information Technologies* personnel for review. The transferring procedure “Copying Error Log Files” is described later in this chapter.

WARNING
This procedure is intended for use by service personnel with advanced troubleshooting skills.

Accessing Error/Event Logs

Some of the information recorded in the error logs is useful for field troubleshooting. The details included here serve as an introduction to the error logs and provide basic information about what you can learn from them.

1. Access *REVIEW ERRORS* starting from the MAIN menu. Select *MORE MENUS -> MONITOR SETUP -> SERVICE MODE.*
2. Enter password using the **TRIM KNOB** control to select the day and month from monitor screen with leading zeros (e.g., July 4 = 0407).
3. Select *REVIEW ERRORS.*

The menu provides six error log choices, three for viewing error logs and three for clearing the error logs. It also provides two event log choices, one for viewing and one for clearing.

Error Logs

1. Select *VIEW SCOPE ERRORS* to view one error in the log of errors.
2. The error log in a monitor holds 50 errors that can be accessed with the *NEXT* or *PREVIOUS* command. The errors display one error at a time in the upper right corner of the screen. Watch the error number category to keep track of which error you are viewing. If one error code seems significant, select *PRINT.* The error code prints out at the central station determined by the monitor’s graph destination menu.

   The *VIEW TRAM ERRORS* option provides a list of errors from the Tram module. It appears very similar to the monitor’s listing.

   The *VIEW INTERFACE ERRORS* option provides a list of errors from the Tram-net interface adapter, Octanet connectivity device and Unity Network ID connectivity device. It appears very similar to the monitor’s listing.
3. To clear all the errors in the error log, select *CLEAR SCOPE ERRORS*, *CLEAR TRAM ERRORS*, or *CLEAR INTERFACE ERRORS* menu option. Be aware that once the clear menu option is executed, all selected errors in memory are erased.

Event Log

The event log holds a record for each event the index, date, and time display. These are followed by the event code, event-specific data and a textual description of the event code.

1. Select *VIEW SCOPE EVENTS* to scroll through the log of events.

   The event log holds 800 events that can be accessed by using the **TRIM KNOB** control. You may select *PRINT* to print out an event.

2. To clear all the events in the error log, select *CLEAR SCOPE EVENTS* menu option. Be aware that once the clear menu option is executed, all selected events in memory are erased.

Useful Error Data

Below is sample error log followed by a description of parameters found in the error log.

RUN TIME ERROR LOG

Status Register:	4
Program Counter:	1350A8
User Stack Pointer:	41898E
Super Stack Pointer:	43FFE8
Heap Pointer:	435EEE
Process Name:	menu<-exec
Error Code:	70E
Severity:	Continue
Date:	SEP 17 1999
Time:	8 :54 :19
Error Number:	1512

414982-001 VER 1A 6 APR 00

Definition of Parameters	
Name	Description
Process Name	The name of the software task that was operating when the event/problem occurred.
Error Code	A code for the type of event/problem that occurred.
Severity	Indicates the impact of the event/problem on the system.
Date	The date the event/problem occurred.
Time	The time the event/problem occurred.
Error Number	A sequential number that is used to identify each event/ problem.

For some categories of Tram-net network errors, two additional lines are added to the error log entry.

Definition of Parameters	
Name	Description
Network Error	Identifies that a network error occurred.
Channel Number	Identifies the network channel exhibiting the error.

Severity is a measure of how the event/error affected the system. There are three levels of severity.

Definition of Severity Levels	
Levels	Description
Continue	The event/error was logged, the task may have or may not have been finished, but the system was able to go on. Most log entries will have a severity of *CONTINUE*.
Fatal	The event/error was such that the task is not able to go on. Recovery was not possible. This always is followed by a WARM START.
Forced Restart	The system was restarted by a known condition (internet address change, video test, etc).

What Error Codes Mean

The error log contains more than just operating system errors. Many events that have an impact upon the system are also entered into the log. The 700-series of error codes are really system initiated events. Listed below are some of the event/error codes you might find useful.

Definition of Parameters	
Error Code	Description
400-4FF	Network errors were detected.
703	Diagnostic tests were completed.
70B	Internet address was changed. The network address for the monitor was changed. This should only be done by qualified service personnel.
70C	Video test was completed. This test should only be performed by qualified service personnel.
70D	Rear power switch was turned off.
70E	Time was changed from this monitor. This helps determine how the system-wide time may have been altered.
70F	Date was changed from this monitor. This helps determine how the system-wide date was altered.
710	Incompatible software was detected. If the main processor software finds that the software operating on the communication software is incompatible, it turns off the communication (network) controller and enters this data into the error log. If the monitor won't "talk" to the network, looking for this entry in the error log is one part of the troubleshooting process.
714	Incompatible TRAM module software was detected. If the main processor software finds the software revision in the TRAM is incompatible, it turns off communication with the TRAM and enters an error log. Refer to the software compatibility listing in the *SOFTWARE REVISION* window.

NOTE

The monitor may be referred to as a display or scope in the error code descriptions.

Useful Event Data

The event log tracks alarm events and other changes to the system that can be useful in determining the state of the monitor if an error occurs. For each event, the event log records the event number, the date, the time, the event ID, the "bucket," and an event description. Additionally, an event description code is logged.

NOTE

"Bucket" data is information regarding the state of the event. For example, if the monitor's automatic alarm graphing is turned on or off, the event bucket will contain the number 0 or 1, which correspond to off and on.

The table below shows some common events, their event codes, the corresponding bucket data (if applicable) and other event data (if applicable). This data can be useful in interpreting the event log.

Event Description	Event ID	Bucket Data	Other Event Data
Alarm Graph On/Off Change	800	0 = Alarm graphing turned OFF 1 = Alarm graphing turned ON	
Graph Location Change	801	1 = Manual graph location changed 2 = Alarm graph location changed 3 = Print window location changed 4 = 12 lead print location changed	Text describing the graph name is shown.
Monitor Defaults Change	802		Text describing the default changed is shown (e.g., *COLOR FORMAT*).
Alarm Limits Change PPtt	803	Limit is indicated in hex.	
Viewing Another Bedside On	804	1 = Split View 2 = Full View	Text describing the viewed bedside name is shown.
Viewing Another Bedside Off	805	1 = Split View 2 = Full View	Text describing the viewed bedside name is shown.
Network Connection Change	806	0 = Stops communicating 1 = Starts communicating	
TRAM/ECG Module Connection Change	807	0 = Stops communicating 1 = Starts communicating	

Transferring Error Logs

General

The following procedure describes how to copy the patient monitor and parameter module error logs and then transfer them to a diskette at the Centralscope central station. To transfer error files from a Clinical Information Center (CIC), refer to the CIC Field Service Manual.

A Centralscope or CIC central station can perform normal patient data display tasks and act as a remote terminal. The remote terminal function is useful for retrieving, viewing, and saving error logs from any GE Medical Systems *Information Technologies* patient monitoring equipment communicating on the Unity Network. Through a series of menus, a device such as a monitor, another central station, or parameter module, can be selected in any care unit. Then a device error log for a particular day may be chosen.

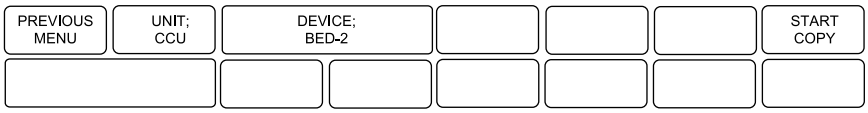
Once the desired error log is selected it can be copied over the network to a floppy diskette in the central station's floppy diskette drive. Since the error logs are text files they can be read into other computers and using most text editors or word processing applications.

Use the following procedure to transfer error files from a Centralscope central station.

CAUTION
This procedure is intended for use by service personnel with advanced troubleshooting skills. Do not "experiment" with these commands! The consequences of misuse include loss of patient data, corruption of the central station operating software, or disruption of the entire Unity Network.

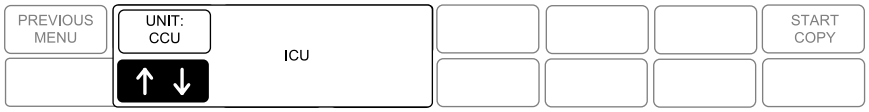
Access the *COPY LOGS* Menu

1. Beginning with the Centralscope central station MAIN MENU select *CENTRAL SETUP -> SERVICE*.
2. Enter password: **MEI CS 123**
3. Select *COPY LOGS*. The *COPY LOGS* menu displays.



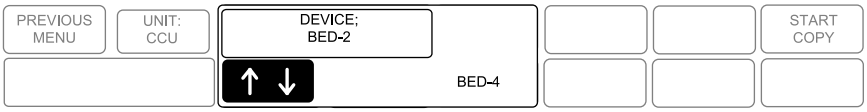
Select the Care Unit

1. Select *UNIT:*
2. Using the **TRIM KNOB** control, change the displayed care unit name. When the desired care unit name displays, press the **TRIM KNOB** control.



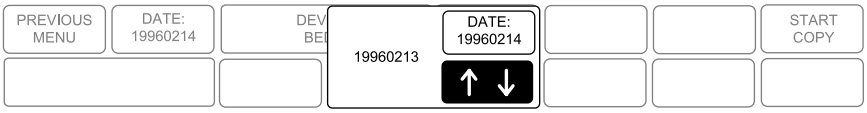
Select the Monitoring Device

1. Select *DEVICE:*
2. Using the **TRIM KNOB** control, change the displayed device name. Note that only monitoring devices within the previously selected Care Unit show. When the desired monitoring device name displays, press the **TRIM KNOB** control.



Select the Error Log Date

1. Select *DATE:*
2. Using the **TRIM KNOB** control, change the error log date. Note that one of the selections is *ALL*, which retrieves all stored error logs from the specified device. When the desired date displays, press the **TRIM KNOB** control.

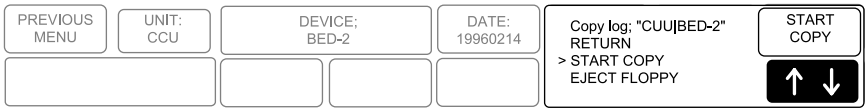


Copy Error Logs

Once the care unit, device, and date have been specified the final step is to begin copying the error logs to the floppy diskette.

1. Insert a PC-formatted, high-density floppy diskette into the floppy diskette drive of the central station.
2. Select *START COPY*. A new display appears that confirms the file source device.

Using the **TRIM KNOB** control, select the desired function. Press the **TRIM KNOB** control to start.



Once the copy function begins the START COPY button changes to show the function: “copying.”

Eject Floppy

Select this option to eject the floppy diskette from the central station’s disk drive.

For your notes

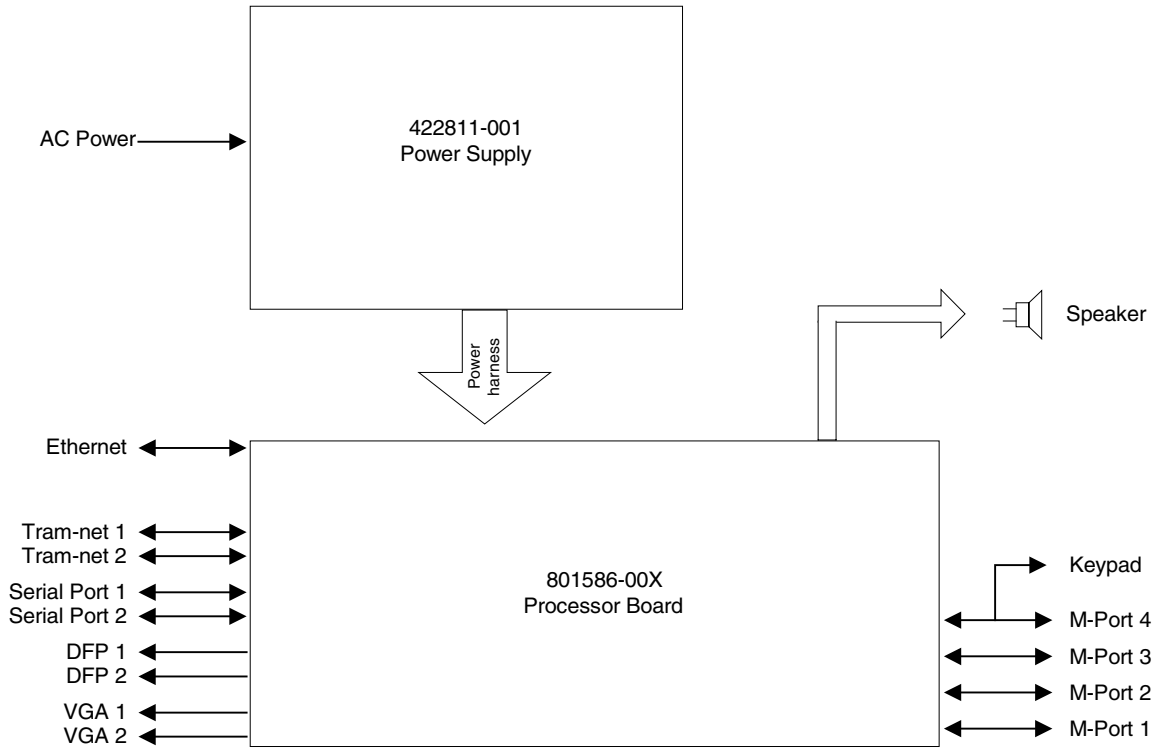
7 Replaceable Parts

For your notes

Theory of Operation

The Solar 8000M patient monitor consists of a processor board, a power supply board, and a speaker. Software running on the processor board processes incoming data, services the communication channels and performs the general functions. Software upgrades are downloaded using a laptop computer or from the central station or CIC (Clinical Information Center) using the Unity Network.

The following theory of operation provides an overview of the various functional circuit boards in the monitor.



NOTE

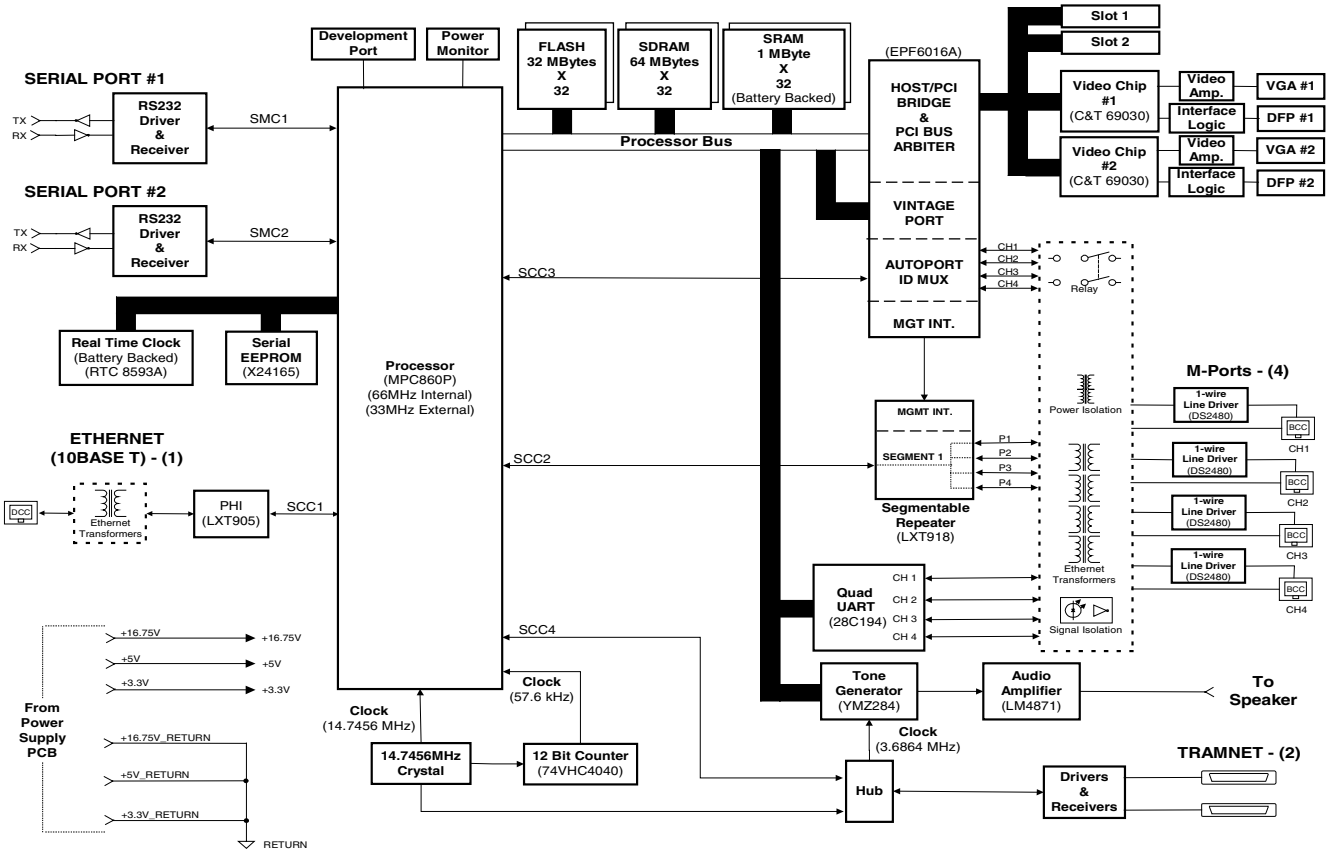
DFP 2 and VGA 2 are only available on Solar 8000M systems with dual display (product code 3S).

Processor Board

The processor board processes acquired data for the generation of displayed information, audible alarms, and supports communication channels for the acquisition system, serial peripherals and the Unity Network.

NOTE

Video Chip #2 is only available on Solar 8000M systems with dual display (product code 3S).



Core Processing System

The core processing system of the processor board is the microprocessor, the memory subsystem and the peripheral set.

The Microprocessor

The Motorola PowerPC MPC860P, operating internally at 66.66 MHz and 33.33 MHz externally, is the microprocessor used in the Solar 8000M processor PCB. The MPC860P consists of a PowerPC core with a System Interface Unit (SIU) and Communications Processor Module (CPM).

The main facilities integrated into the MPC860P include:

- PowerPC Core including:
  - 16k of Dual ported RAM for registers and microcode
  - A Memory Management Unit (MMU)
  - 16 kByte Instruction Cache
  - 8 kByte Data Cache
- System Integration Unit (SIU) including:
  - Memory Controller and Wait State Generator via Eight(8) General Purpose Chip-Select Machines (GPCM) and two(2) Universal Programmable Machines (UPM)
  - Development Port/Background Debug Monitor
  - System Configuration and Protections such as the Bus Monitor, Software Watchdog Timer, and Periodic Interrupt Timer
  - PLL Clock synthesizer
- Communication Processor Module (CPM) including:
  - One (1) Fast Ethernet Channel (Media Independent Interface)
  - Four SCCs, all of which can do IEEE 802.3 Ethernet
  - Two SMCs (UARTs)
  - One SPI Interface
  - One I2C Interface
  - Seven IRQ lines
  - I/O port pin banks, some of which can be programmed to generate an interrupt when a condition is present

A Development Port, commonly referred to as a Background Debug Monitor (BDM) debug port on other processors, is resident in the MPC860 to assist in debugging and troubleshooting the processor operation.

NOTE

The MPC860 is +5V I/O tolerant on all of its pins except for the clock input. This is important because the signals from the Tram-net Hub are +5V signal levels.

Memory Subsystem

The processor PCB provides the memory resources necessary for code storage and execution, and nonvolatile and configuration data storage by providing the following:

- FLASH Memory for Boot Code, Main Code and Parametric (TMSS) Storage Memory,
- DRAM Memory for Code Execution and Volatile Data Storage, and,
- SRAM Memory that is battery backed for Nonvolatile Data Storage.
- EEPROM Memory for network configuration data.

The memory subsystem utilizes the memory controller facility of the MPC860. This allows for the addresses, strobe generation and wait stating to be under software control.

FLASH – The FLASH memory array consists of two (2) 128 Mbit devices providing a total of 32 Mbytes of nonvolatile storage configured 32 bits wide. The FLASH memory has an access time of 150ns so it is not efficient to execute Main Code out of it. The FLASH memory is writeable by the MPC860 to allow for code updates and parametric data storage.

The Boot and Main Code is stored in FLASH memory. The reason that the Code is stored, but not executed out of the FLASH memory array is because it is too inefficient to incur the wait stating necessary to accommodate the long access time. Therefore, transferring the code to the DRAM space and executing out of the DRAM is done.

The 32 Mbytes of FLASH memory is adequate to allow ~8 Mbytes for the parameter storage needed to implement the “Trend Memory Storage System” (TMSS) facility.

DRAM – The DRAM memory array consists of two (2) 256 Mbit Synchronous DRAM devices providing a total of 64 Mbytes of volatile memory storage configured 32 bits wide. The DRAM bank is used for executing the transferred Main Code, which was stored in the FLASH, and for scratch pad data storage. The interfacing and the refreshing of the DRAM array is done by the Universal Programmable Machine A (UPMA) in the MPC860.

At system startup, the Code is transferred from the FLASH memory into the DRAM memory for efficient execution. Since the total FLASH is 32 Mbytes, that much space has been allocated in the DRAM for the Main Code. However, since part of the FLASH space is also for TMSS parameter storage, which is not transferred into the DRAM, there is extra space for data storage such as for a Laser printer output.

The portion of the DRAM remaining after the transfer of the Main Code is available for volatile data storage and general-purpose scratched memory.

SRAM – The SRAM memory array consists of two (2) 4 Mbit SRAM devices providing a total of 1 Mbyte of nonvolatile memory storage configured 32 bits wide. The Chip Enable gating facility in the MAX793 Power Monitor disables the writing to the SRAM while the Reset signal is asserted to protect the SRAM contents during power changes. The SRAM memory is nonvolatile because it is Lithium battery backed. The SRAMs retention of data will be five (5) years after the date of manufacture of the PCB.

Peripheral Set

Clock Source – The central clock source for the processor PCB is a crystal oscillator with a frequency of 14.7456 MHz.

The Tramnet Hub and Tramnet SCC Timing and the FPGA general clocks are directly sourced by the output of this oscillator.

The Quad UART Baud Rate Clock and the Audio Clock are derived by dividing the oscillator output by 4 to provide a frequency of 3.6864 MHz.

The MPC860 PLL input of 57.6 kHz is derived by dividing the oscillator frequency of 14.7456 MHz by 256. The internal Phase Lock Loop (PLL) generates an internal frequency of 66 MHz from this external source. The external bus speed is 33 MHz for memory accesses and peripherals.

Power Monitor, Watchdog and Battery Switch – The MAX793 provides the following facilities:

- Power-on reset
- Battery switchover
- Battery charge level indication (battery OK)
- Power going away indication (Low Line)
- SRAM chip select gating
- Manual reset input
- Watchdog facility

The ability to defeat the watchdog is provided by having a FET switch in the watchdog output that can be opened. When the FET is on (switch closed) the watchdog output is applied through a diode to the manual reset input. The state of the watchdog, enabled or disabled, is readable by the MPC860 at a port pin.

Real Time Clock – The Epson RTC-8593AA is the Real Time Clock (RTC) used. It is an I2C RTC with an internal crystal and can operate with a supply voltage of +3.3V. The storage of the year will have to be done in another location since this RTC has only 2 bits for storage of the year. The RTC must be battery backed to insure that the time is continued to be kept during power down periods. The I2C address for the RTC is “1011xxxx”.

Serial EEPROM – The serial EEPROM used is a Xicor X24165. The X24165 is a 16k bit part organized as 2k x 8, I2C compatible and a +3.3V part. The data stored in the EEPROM would be the Ethernet Address, IP Address, Software level, product type, year and Power-Applied Indication. The I2C address for the EEPROM is "1010001x".

NOTE

The serial EEPROM on the Solar 8000M processor PCB is not removable.

Audio Tone Generation and Output Amplifier – The Solar 8000M processor PCB provides audio output for alarm and parameter tones.

The tone generator used is the Yamaha YMZ284. The YMZ284 can make three (3) simultaneous tones and individually attenuate the amplitude of the three (3) tones. The YMZ284 is a +5V part, but since it is a write only part, it can sit on the MPC860 bus without voltage translating buffering required.

The audio amplifier used is the National LM4871. The LM4871 can deliver 1.1W of power into an eight (8) ohm speaker load from a +5V supply and since it operates in a push-pull fashion, it does not require any coupling capacitor. The LM4871 is protected from output short-circuiting by having a 0.75A PTC in its +5V line.

FPGA Logic Chip – The Processor PCB has one (1) Field Programmable Gate Array logic chip on the board to provide the PCI host bridge interface, the Tramnet strobe processing, the M-port support and a revision port. The FPGA used is an Altera 6016 FLEX FPGA. The FPGA is configured at power up by the Boot Code startup software loading the FPGA configuring data into the FPGA. Therefore the FPGA does not contain any functionality that is needed to allow the MPC860 to access and execute Boot Code or any other necessary facilities needed to get the processor PCB initialized at startup. In addition, any signal lines that the FPGA drives must be able to accommodate the fact that at power up the FPGA lines are high impedance until the FPGA is programmed.

NOTE

The FPGA must be 5V I/O tolerant since it is interfacing the older +5V technology parts such as the Tramnet Hub.

The reason that the strobes to the SRAM are generated with discrete "AND" gates is to remove the dependency on the FPGA from being functional at power up.

The FPGA contains a MPC860 bus to PCI bus bridge intellectual property (IP) core. See the Video System section for a detailed discussion.

The FPGA contains a section to process Tramnet strobes from the Hub. See the Communications section for a detailed discussion.

The FPGA divides the 33.33 MHz clock to provide a <20 MHz clock for the Quad UART. The FPGA also provides the multiplexing a SCC3 between the four (4) M-Port ID interfaces and the LXT-918 Serial Management Interface. See the Communications section for a detailed discussion.

The revision port implemented within the FPGA provides an eight (8) bit revision for the FPGA code readable by the software for verification.The revision value is displayed as ASCI in the Boot Loader information.

Video System

NOTE

The dual display is only available on Solar 8000M with the product code 3S.

The video system consists of two (2) duplicate video sets. The reason for two (2) video sets is to provide the hardware capability for having independent images and to allow the use of the same type of display (CRT or Flat Panel) on both video sets.

A 14.31818 MHz clock oscillator is a common clock source between the two(2) video sets. The MPC860 accesses the video systems over the PCI Bus using the Host Bridge implementation within the FPGA.

Video Set Components

Each video set has a video graphics chip, some discretes and connectors for VGA (RGB) and DFP (Digital Flat Panel) video displays as well as a RS-232 Serial Port to provide for a Touchscreen input. The number of video sets varies by configuration.

Video Graphics Chip – The video chip used is the Asiliant, formerly Intel/Chips & Technology, B69030 which has the following facilities:

- 4 Mbytes of internal memory
- A bandwidth of 800 Mbytes/second
- RAMDAC for direct VGA/RGB output
- Flat Panel Drive
- Programmable Ports Pins

VGA Video Output – The RGB output from the 69030 directly drives the 15 pin VGA connector.

DFP Video Output – Flat Panel drive signals from the B69030 are interfaced to a Silicon Image SiI154 to be converted to Transition Minimized Differential Signaling (TMDS) levels then connected to the 20 pin MDR DFP connector.

DDC – Data Display Channel (DDC) capability is provided on both the VGA and DFP connectors using the output port pins on the 69030 and then level shifting the +3.3V referenced I2C signals to +5V levels using two MOSFET's. The +5V sourced as part of the DDC facility is limited by a 750 mA PTC.

Video Interrupts – Each 69030 supplies a video interrupt to the MPC860, which is connected to the PCMCIA Input Port Pins. The four (4) interrupt lines and the two (2) Present lines from each of the PCI slots are also connected to the PCMCIA Input Port and are provided to facilitate the use of the PCI slots for future video development.

RS-232 Serial Port

The RS-232 Serial Ports provide the interface to serial communication devices such as a touch screen display. See the Communication System for detailed discussion.

PCI Bus Implementation

The PCI Bus is used to communicate with the video chips and the two (2) expansion slots. The PCI Bus is a 32 bit, 33MHz implementation.

MPC860 to PCI Bus Host Bridge – The PCI Bus interface to the MPC860 Bus was accomplished by implementing a purchased Intellectual Property (IP) design in the FPGA for a Host Bridge and PCI Bus Arbiter.

PCI Expansion Slots – The Processor PCB provides two (2) PCI slots to allow for the software development with new video chips that may become available during the life of the Solar 8000M product. Also, the PCI expansion slots allow for the debugging of the PCI bus by providing the means to have a PCI Bus analyzer monitoring the PCI Bus activity.

The PCI expansion slots are +3.3V compatible.

PCI Bus Agents – Agents on the PCI Bus:

- Host Bridge
- Video Chip - #1
- Video Chip - #2

  NOTE

  Video Chip #2 is only available on Solar 8000M systems with dual display (product code 3S).

- Slot #1
- Slot #2

Communication System

Ethernet for Unity

The Processor PCB provides one (1) IEEE 802.3 10BaseT compliant Ethernet port. This port is implemented using an SCC within the MPC860 and an LXT905 Serial Interface Adapter. An Ethernet Port Address label is affixed to the connector bracket and visible to the user without disassembly.

Processor SCC Channel – The first Serial Communication Controller (SCC) is used to implement the Ethernet channel.

Serial Interface Adapter – The LXT905 is used as the Serial Interface Adapter (SIA) for each Ethernet channel.

A 20 MHz crystal is used to provide the clock source for the LXT905 SIA for the Ethernet Channel.

Status LED's for Transmit, Receive, Collision and Link OK are provided for the Ethernet channel.

The Ethernet channel allows for testing of the channel by using an external loopback connector. Software is able to implement this type of test by activating the “Full

Duplex Enable” and the Loopback functions within the LXT905 via the MPC860 port pins.

The Ethernet channel meets the spacing and dielectric voltage withstand requirements for UL60601-1 Basic Insulation at 250Vac. This is best accomplished by using a signal isolating transformer and a bleed resistor in the ESD protection network that can withstand the application of 1800Vrms for 5 seconds and by insuring surface creepage distance of four (4) mm minimum. The reason for the 1800Vrms limit is that production line testing is required on each unit and this will be done using the approved time saving conditions of 1800Vrms for one(1) second, rather than the customary 1500Vrms for one (1) minute.

The Ethernet connectors are ESD protected by using the planar capacitance method since they are isolated from an earth connection. The typical diode/transzorb pair is employed to clamp the Ethernet connector pin to its isolated return plane. The impedance of the connector contact, the ferrite bead and the copper traces form an impedance divider with the 'planar' capacitor formed by the dielectric material in the PCB layer between the copper of the isolated return plane and the copper of the common (earthed) plane. The expectation is that the physical impedance divider formed by the bead/trace/connector inductance and the planar capacitor will accomplish the following two results:

- Limit the rate of rise of the voltage across the isolation barrier, i.e., across the planar capacitor, and
- Limit the peak amplitude to which the voltage across the barrier rises to.

Tramnet (2 Ports)

The Processor PCB provides an interface to the GE-MMS proprietary Carrier Sense Multiple Access/Collision Detection (CSMA/CD) network, Tramnet, by providing a Tramnet Controller (TNC) and a Hub facility.

Processor SCC Channel – The fourth Serial Communication Controller (SCC) is used to implement the Tramnet Controller. This is done by operating the SCC in transparent mode and using software to provide the functionality that was originally provided by an external communications processor.

Hub – The Hub chip is the Solar 9000 FPGA implementation. It accommodates the TNC port as well as four (4) external ports functioning as a “Header Hub”. The Header Hub “turns the signal around” by sending the “Up” signal out on the “down” path, generates the carrier sense signal so that the TNC will not cause an “out of window” collision, generates Collision Presence signals at the detection of a collision, and retimes the bits.

NOTE

The signals out of the Hub are at +5V signal levels, so any +3.3V devices interfacing to the Hub must be +5V tolerant.

The Squelch input is a valid signal received indicator. The meaning of the signal name is to ignore all noise, i.e., to squelch the noise, on an undriven receiver input. To enable the Hub to determine when valid data is present on the Tramnet receiver, a qualifying (squelch) signal is generated by requiring the incoming signal to exceed a higher threshold than what noise disturbances would be likely to generate. The Squelch signal is generated by the second receiver in the DS8923 Dual Differential Driver/Receiver pair by having the receiver's threshold shifted so that this receiver only transitions its output for incoming signals that have a differential swing of greater than +/-250mv beyond the 200mv sensitivity of the receiver. This signal,

which has been qualified by the increased threshold to insure it is valid data and not noise, is used by the Hub chip to generate a carrier sense signal by letting the squelch signal edges control a time-out counter.

The Tramnet Hub Signals TX_CLOCK, RX_CLOCK and RX_ENABLE signals are connected through the FPGA along with the 14.7456 MHz clock to allow for signal processing such as delaying or inverting to allow the Tramnet SCC to use these hardware generated signals to better frame the incoming Tramnet packet.

Another facility provided by the FPGA is to accommodate the +5V signal levels provided by the Hub since the FPGA is +5V tolerant.

Drivers and Receivers – The DS8923 Dual Differential Driver/Receiver pair is used to convert the signals between the Tramnet differential RS-422 level and TTL levels.

Isolation – The Tramnet signals are electrically isolated with signal transformers. The Tramnet power source is not isolated before being delivered to the Tramnet network.

ESD Protection Scheme – The typical diode/transzorb pair is employed to clamp the Tramnet connector pins to the common return plane. Since the Tramnet is really not an electrically isolated network, the need for maintaining isolation in the ESD protection scheme is not present.

M-Ports (4)

ID Signal – The ID Signal is generated using a Dallas Semiconductor 1-Wire Line Driver chip, DS2480. The DS2480 is interfaced by the MPC860's SCC3, which is multiplexed in the FPGA across the four (4) M-Ports. The benefit of the DS2480 is that it relieves the MPC860 of doing most of the timing for the interface to the 1-Wire memory device, such as the DS2430 out in the DIDCA device. Also it improves noise immunity by reading at the latest possible time and it minimizes emissions by driving the line with a controlled edge rate and controlled drive current. The rate at which the DS2480 can receive new commands or transfer additional bytes of data is synchronized by the MPC860 waiting for a received character interrupt response from the DS2480 before it can load the next character. The ID signal has its own Return line. The ID Signal and its Return share the RJ-45 connector pins that the M-Port Ethernet 10 Base T Transmit differential pair uses. The functionality of the shared connector pins is determined by a relay under software control.

RS-232/UART Interface – The M-Port RS-232 interface is provided by a Philips SC28L194 Quad UART (one UART per M-Port) and an Analog Devices ADM202E RS-232 Driver/Receiver. The SC28L194 Quad UART has sixteen (16) byte FIFO's on both the receiver and transmitter and I/O port pins that function as status LED drive signals. The benefit of the FIFOing is to reduce the overhead to the MPC860 to service the UART's. The Quad UART uses the auto vectored interrupt on level 3.

Ethernet Facility – A Level One LXT-918 Ethernet Repeater provides each M-Port with Ethernet capability. With the relay in the Ethernet position, pins 3 and 6 in the RJ-45 connector provide the Ethernet Differential Transmit pair. The Ethernet receive pair are provided on pins 1 and 2 of the RJ-45 connector.

NOTE

The M-Port provides Host or Hub pinouts, not device side pin outs, so that a one-to-one Category 5 cable can be used to connect any Ethernet device up using an M-Port.

The Serial Management Interface (SMI) to the LXT-918 Ethernet Repeater is provided by reprogramming SCC3 in the MPC860 to be an HDLC controller and setting the appropriate MPC860 port pins to get the proper muxing action within the FPGA. The use of the SMI is to determine which M-Ports have a functioning 10BaseT Ethernet connection on them without having to switch the relay back to ID mode and interrogate for a One-Wire interface.

NOTE

The clock source for the SMI is selected by the MPC860 to be either sourced by itself or by the LXT-918 under software control.

M-Port Power Sourcing – Each M-Port is capable of providing +5V +/- 5% @ 100mA into an external load.

Isolation – Per the M-Port Specification, Basic Insulation for 250Vac is provided between each M-Port and any other isolated facility and from earth ground.

Signal isolation is provided by HP HCPL063A dual optocouplers for both the ID interface and the RS-232 signals.

The DC power for each M-Port is isolated by using a MAX845 transformer driver, an isolating transformer and a MAX883 Low Dropout Regulator.

ESD Protection Scheme – The M-Port connectors are ESD protected by using the planar capacitance method since they are isolated from an earth connection. The typical diode/transzorb pair is employed to clamp the connector pin to its isolated return plane. The impedance of the connector contact, the ferrite bead and the copper traces form an impedance divider with the 'planar' capacitor formed by the dielectric material in the PCB layer between the copper of the isolated return plane and the copper of the common (earthed) plane. The expectation is that the physical impedance divider formed by the bead/trace/connector inductance and the planar capacitor will accomplish the following two results:

- Limit the rate of rise of the voltage across the isolation barrier, i.e., across the planar capacitor, and
- Limit the peak amplitude to which the voltage across the barrier rises to.

RS-232 Serial Ports

Both RS-232 Serial Ports are associated to a video set as described earlier to accommodate a touchscreen. However, the serial ports are limited to being a Touchscreen interface on RS-232 2 and a Polled Data Service Facility can be used on RS-232 1.

Processor SMC Channels – The RS-232 1 Serial Port uses the SMC1 and the RS-232 2 Serial Port will use SMC2 in the MPC860.

Isolation – The RS-232 Serial Ports are not isolated with respect to earth ground.

ESD Protection Scheme – The typical diode/transzorb pair is employed to clamp the RS-232 Serial Port connector pins to the common return plane. Since the RS-232 Serial Ports are not electrically isolated, the need for maintaining isolation in the ESD protection scheme is not present.

I^2C Bus

The I^2C bus is used to interface to the Real Time Clock and the Serial EEPROM.

SPI Interface

The SPI is used to program the FPGA.

Power Supply

The power supply generates DC voltages necessary to power the processor board and the communication channels (M-ports and devices connected to Tramnet). It consists of a mains (AC line) PWM converter, that creates a 16.75 output voltage bus from which two outputs are developed. The main 16.75V output also provides external power to the RAC and data acquisition plug-in modules.

16.75 Volt AC Mains Converter

The mains converter is a two transistor forward converter that takes the AC line input and creates a regulated 16.75 bus voltage.

EMI Input Filter/ Rectification

The AC line input comes onto the board via the AC power entry module J3. The input AC lines are over current protected by fuses F2 and F3. RT1, in series with the line, is a negative temperature coefficient thermistor used to limit inrush current when the supply starts cold. Following the thermistor, is an EMI filter, which consists of common mode choke L9 and associated capacitors. Resistor R82 discharges the input filter capacitors when the supply is turned off.

Rectification is accomplished by bridge CR15. There are two modes of operation depending on the setting of line voltage control switch S1. In the 115 volt position the circuit works as a voltage doubler charging the top bank of storage capacitors consisting of C66 and C82 on one half the line cycle and charging the bottom bank of capacitors consisting of C56 and C57 on the opposite half cycle. The two half cycles are added in series to create VBULK. When S1 is in the 230V position it works as a standard bridge rectifier with the upper and lower bank of capacitors connected in series. Resistors R24 and R62 are used to keep the voltages on the two series connected capacitors balanced.

CR7 and CR14 are transient suppressor diodes used to clamp VBULK in the event of a line surge or transient.

Bootstrap Startup Circuit

The PWM controller U13 requires a minimum of 16 volts (typical) to start. Resistors R24 and R62 supply the current via CR13 to charge the bulk bypass capacitors for U13, C57 and C64. R23, R43 and R61 form a voltage divider off VBULK to bias a proportional clamp consisting of Q3 and Q4. This clamp prevents the controller from starting until VBULK has reached a minimum level. After the voltage is high enough to enable U13, the reference output (VREF) at U13-14 biases the gate of Q5 to turn it on. This effectively connects R24 to power ground, which balances the voltages on the two banks of bulk storage capacitors.

U14 and associated components are used to linearly regulate the voltage at U13-11 (VC) to a lower voltage. Since the VC voltage provides drive to the output circuit, a lower voltage reduces switching losses in Mosfet power transistors Q10 and Q11.

+16.75 Volt Bus

U13, a peak current mode PWM controller, regulates the +16.75 volt bus. The switching frequency is determined by components C49, R36 and R37.

The controller is soft-started to limit the duty cycle in order to reduce stress on the power switching components when the output capacitors are in a discharged state.

R34 and C46 determine the soft start time. The output of the error amplifier (U13-1) is clamped by CR11 to the voltage on C46. Since the output of the error amplifier determines the duty cycle, as the voltage on C46 increases the duty cycle is allowed to increase. As C46 is charged to VREF, U13's output can go to maximum duty cycle, which is internally limited to 50%.

The PWM drive output at U13-10 (PWMDR) is clamped by schottky diode CR18 to prevent negative voltages from damaging the controller.

Transformer T2 is used to connect the output of the controller to the power switch consisting of Q10 and Q11. When the output at U13-10 goes high Q9 is turned on, which applies a positive pulse to the gates of Q10 and Q11 via T2. The turn-on rise time is determined by the values of R67, R75, and R81. When PWMDR goes low Q9 is turned off, which turns the power switch off.

A proportional clamp is used to reset T2. When Q9 is turned off the voltage at T2 pin 4 will go negative until it is clamped by CR20 to the negative voltage on C81. R68 determines the clamp voltage by partially discharging C81 during Q9 on time.

Resistors R79 and R80 along with capacitors C90 and C92 make up a snubber circuit which is used to minimize ringing when Q10 and Q11 turn off. CR22 and CR23 clamp the voltage across Q10 and Q11 respectively so that the maximum voltage across either transistor will be VBULK.

Q10 and Q11 form a switch, which connects VBULK across the primary of transformer T1 during the on time. CR16 and CR21 are dual common cathode diodes. The diode in series with the secondary winding conducts during the power switch on time and the diode in series with the low side of each output conducts during the switch off time. During the on time current flows through inductors L5 and L8 to the associated loads as well as charging the output capacitors. When Q10 and Q11 turn off L5 and L8 will try to go negative until they are clamped by the low side diode in CR16 and CR21. Current then continues to flow via the output inductors to the load. The energy stored in the inductors is reduced during the off state then replenished during the on state.

VR1 on the VCC secondary a clamps the voltage to prevent damage to the control IC.

Volt Current Feedback Control Loop

U13 is a current mode controller, which controls the peak primary current each cycle. The voltage developed across R69, which is a reflection of current in the primary of T1, is the current feedback voltage. The current feedback voltage is divided down and filtered by R48, R49, and C54 and coupled to U13-5 via R39. The voltage at U13-5 controls the level of peak primary current.

Q2 and associated components are used to provide slope compensation. A portion of the oscillator signal at U13-7 is buffered by Q2 and added to the current feedback voltage via R45 and C53. This voltage compensates for the downslope of current in the output inductor, which is unknown to the controller.

Volt Voltage Feedback Control Loop

The 16.75V output is sampled via a voltage divider consisting of R53, R63, and R64. The sampled voltage appears at the U10-8. U10 is a shunt regulator with a built in 2.5V reference, which varies the output drive current at U10-1 in order to maintain the voltage at U10-8 at 2.5 volts. This current drives the photo diode in opto-isolator U12, which in turn provides bias current for the photo-transistor. The photo-transistor emitter current at U12-4 develops a voltage across R60. This voltage is coupled to the controller error amplifier via R42 and R46. C73 along with R65 determine the low frequency gain of the voltage loop. C63 with R60 compensate for the ESR zero of the output capacitors.

Volt Fault Circuit

When a fault occurs on the 16.75V rail a timer is started which will shutdown the PWM circuit if the fault lasts longer than a set amount of time. The circuit will continually try to restart until the fault is cleared. The 16.75V output is monitored via voltage divider R51 and R52. The divided voltage is coupled to the input of voltage comparator U8-5. Reference U9 holds U8-6 at 2.5 volts. When the voltage at U8-5 drops below 2.5 volts the output at U8-7 goes low turning Q7 off. This removes the drive to opto-isolator U11, which in turn removes the drive to Q8. This allows the voltage on capacitor C44 to begin to charge via R33. When the voltage reaches the threshold of the timer U14-7 is pulled low. This action causes the soft start capacitor C10 to be discharged which in turn causes the PWM to shutdown. After a period of time VCC (U13-12) will drop to the under voltage lockout threshold (approximately 10 volts). When the under voltage threshold is reached VREF is disabled. When VREF is disabled Q6 turns off and bootstrap current is now allowed to flow via R9 and R10. At this point the bulk VCC capacitors C12 and C43 will be recharged to 16 volts, via the bootstrap resistors, in order to restart the PWM. This cycle will repeat until the fault is cleared.

+5V DC-DC Converter Circuit

U5 (LTC1435A) is a high efficiency low noise synchronous step-down switching regulator. It uses constant frequency architecture with the frequency determined by the value of C23. Each time mosfet U4 turns on, the voltage on C23 is reset to ground. During the ramp on time, C23 is charged by a fixed current source. When the voltage on the capacitor reaches 1.19V it is reset to ground. The process then repeats.

Soft start is used to limit the duty cycle when the output capacitors are in a discharged state. Soft start timing is determined by the value of C22. An internal 3uA current source charges up C22. When the voltage reaches 1.3V, U5 begins to operate. As the voltage continues to ramp from 1.3V to 2.4V, the internal current limit is also ramped at a proportional linear rate.

Since U4 is an N-channel mosfet, it has to be driven by a voltage that is greater than 16.75. C17 in conjunction with an internal charge pump effectively doubles the voltage that is applied to the gate of U4. The small amount of charge that is removed from C17 during each on cycle is replenished during each off cycle.

During the first half of the cycle U4 is turned on and current flows from the input rail through L2 to the output. The switch stays on until the current through inductor L2 sensed via the voltage across series current sense resistor R6 is high enough to trip an internal comparator. The output voltage is sampled via resistor divider network R7, R8, and R9. The output can be adjusted by changing the setting of R8. This voltage feedback at U5-6, which is filtered by C19, determines the comparator trip point.

The main control loop will adjust the current trip point in order to maintain a constant output voltage. An internal transconductance error amplifier amplifies the difference between the feedback voltage at U5-6 and an internal reference voltage forming a signal that establishes the required load current. Voltage loop compensation is determined by the values of R14, C20 and C21.

When U4 turns off, the voltage at U5-14 will try to go negative until it biases schottky diode CR5 on. After a short delay, to insure U4 is off, U3 turns on for the second half of the cycle. The current through CR5 is then bypassed through U3, in order to reduce the losses caused by the current flow through CR5. CR4 protects the output from over voltage transients.

+3.3 Volt DC-DC Converter

U6 (LTC1435A) is a high efficiency low noise synchronous step-down switching regulator. It uses constant frequency architecture with the frequency determined by the value of C41. At the beginning of each cycle the voltage on C41 is reset to ground. During the Q6 on time, C41 is charged by a fixed current source. When the voltage on the capacitor reaches 1.19V it is reset to ground, representing the beginning of the next cycle.

Soft start is used to limit the duty cycle when the output capacitors are in a discharged state. Soft start timing is determined by the value of C40. An internal 3uA current source charges up C40. When the voltage reaches 1.3V, U6 begins to operate. As the voltage continues to ramp from 1.3V to 2.4V, the internal current limit is also ramped at a proportional linear rate.

Since Q6 is an N-channel mosfet, it has to be driven by a voltage that is greater than 16.75. C36 in conjunction with an internal charge pump effectively doubles the voltage that is applied to the gate of Q6. The small amount of charge that is removed from C36 during each on cycle is replenished during each off cycle.

During the first half of the cycle Q6 is turned on and current flows from the input rail through L4 to the output. The switch stays on until the current through inductor L4 sensed via the voltage across series sense resistor R25 is high enough to trip an internal comparator. The output voltage is sampled via resistor divider network R7, R8, and R9. The output can be adjusted by changing the setting of R8. The voltage feedback at U6-6, which is filtered by C38, determines the comparator trip point.

The main control loop will adjust the current trip point in order to maintain a constant output voltage. An internal transconductance error amplifier amplifies the difference between the feedback voltage at U5-6 and an internal reference voltage forming a signal level that determines the required load current. Voltage loop compensation is determined by the values of R28, C39 and C43.

When Q6 turns off, the voltage at U6-14 will try to go negative until it biases schottky diode CR8 and CR9 on. After a short delay, to insure Q6 is off, Q1 turns on for the second half of the cycle. The current through CR5 is then bypassed by Q1, in order to reduce the losses caused by the current flow through CR8 and CR9.

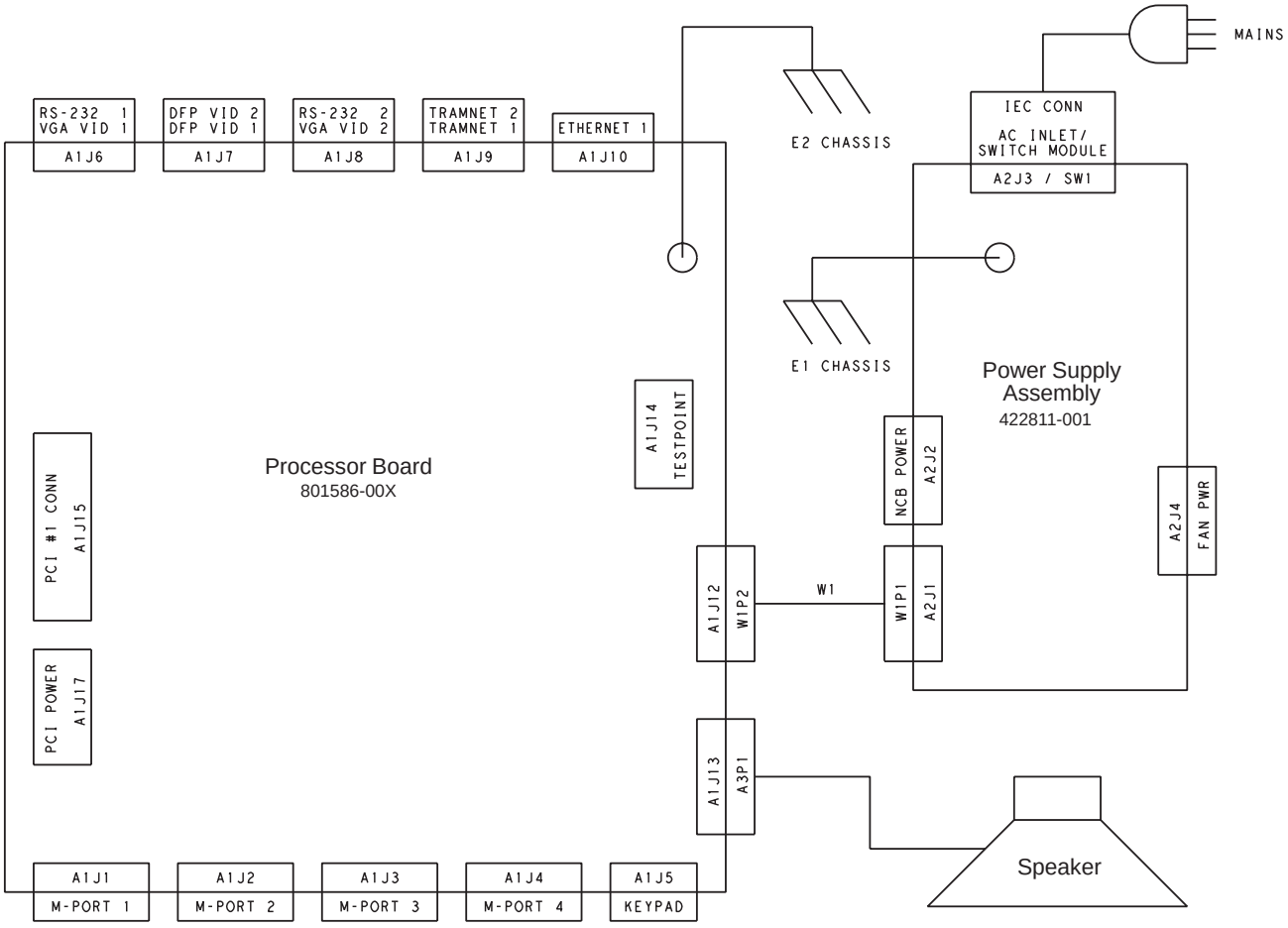
Speaker

The speaker generates sound for alarms, QRS detection, and SpO_2 pulse tones.

Block Diagram of Internal Connections

NOTE

The number of video connectors varies by configuration. DFP VID 2 and VGA VID 2 are only available on Solar 8000M systems with dual display (product code 3S).



Input/Output Connectors and Signals

Pin-by-pin descriptions and the signal names for each connector on the rear panel of the monitor are described in this section.

NOTE

The number of video connectors varies by configuration.

VGA VID 1

Pin #	Signal Name	Type	Description
1	VGA1:RED	Output	Video 1 Red Video
2	VGA1:GREEN	Output	Video 1 Green Video
3	VGA1:BLUE	Output	Video 1 Blue Video
4			
5	RETURN	Return	DDC Return
6	RETURN	Return	Red Video Return
7	RETURN	Return	Green Video Return
8	RETURN	Return	Blue Video Return
9	VID1:+5V_DDC	Output	Video 1 DDC Supply
10	RETURN	Return	Sync Return
11			
12	VGA1:DDC_DATA	Bidirectional	Video 1 DDC Data (SDA)
13	VGA1:H_SYNC	Output	Video 1 Horizontal Synchronizing Signal
14	VGA1:V_SYNC	Output	Video 1 Vertical Synchronizing Signal
15	VGA1:DDC_CLOCK	Bidirectional	Video 1 DDC Clock (SCL)
Shell	RETURN	Return	

VGA VID 2

NOTE

Only available on Solar 8000M systems with dual display (product code 3S)

Pin #	Signal Name	Type	Description
1	VGA2:RED	Output	Video 2 Red Video
2	VGA2:GREEN	Output	Video 2 Green Video
3	VGA2:BLUE	Output	Video 2 Blue Video
4			
5	RETURN	Return	DDC Return
6	RETURN	Return	Red Video Return
7	RETURN	Return	Green Video Return
8	RETURN	Return	Blue Video Return
9	VID2:+5V_DDC	Output	Video 2 DDC Supply
10	RETURN	Return	Sync Return
11			
12	VGA2:DDC_DATA	Bidirectional	Video 2 DDC Data (SDA)
13	VGA2:H_SYNC	Output	Video 2 Horizontal Synchronizing Signal
14	VGA2:V_SYNC	Output	Video 2 Vertical Synchronizing Signal
15	VGA2:DDC_CLOCK	Bidirectional	Video 2 DDC Clock (SCL)
Shell	RETURN	Return	

DFP VID 1

Pin #	Signal Name	Type	Description
1	DFP1:TX1+	Output	DFP 1 TMDS pos. diff. output, Channel 1
2	DFP1:TX1-	Output	DFP 1 TMDS neg. diff. output, Channel 1
3	RETURN	Return	Shield for TMDS Channel 1
4	RETURN	Return	Shield for TMDS Clock
5	DFP1:TXC+	Output	DFP 1 TMDS pos. diff. output, Ref. Clock
6	DFP1:TXC-	Output	DFP 1 TMDS neg. diff. output, Ref. Clock
7	RETURN	Return	Logic Return
8	VID1:+5V_DDC	Output	Logic Supply
9			Reserved - Do Not Connect
10			Reserved - Do Not Connect
11	DFP1:TX2+	Output	DFP 1 TMDS pos. diff. output, Channel 2
12	DFP1:TX2-	Output	DFP 1 TMDS neg. diff. output, Channel 2
13	RETURN	Return	Shield for TMDS Channel 2
14	RETURN	Return	Shield for TMDS Channel 0
15	DFP1:TX0+	Output	DFP 1 TMDS pos. diff. output, Channel 0
16	DFP1:TX0-	Output	DFP 1 TMDS neg. diff. output, Channel 0
17			Reserved - Do Not Connect
18	DFP1:HOT_PLUG_ DETECT	Input	DFP 1 Hot Plug Detection
19	DFP1:DDC_DATA	Bidirectional	DFP 1 DDC Data (SDA)
20	DFP1:DDC_CLOCK	Output	DFP 1 DDC Clock (SCL)
Shell	RETURN	Return	

DFP VID 2

NOTE
Only available on Solar 8000M systems with dual display (product code 3S)

Pin #	Signal Name	Type	Description
1	DFP2:TX1+	Output	DFP 2 TMDS pos. diff. output, Channel 1
2	DFP2:TX1-	Output	DFP 2 TMDS neg. diff. output, Channel 1
3	RETURN	Return	Shield for TMDS Channel 1
4	RETURN	Return	Shield for TMDS Clock
5	DFP2:TXC+	Output	DFP 2 TMDS pos. diff. output, Ref. Clock
6	DFP2:TXC-	Output	DFP 2 TMDS neg. diff. output, Ref. Clock
7	RETURN	Return	Logic Return
8	VID2:+5V_DDC	Output	Logic Supply
9			Reserved - Do Not Connect
10			Reserved - Do Not Connect
11	DFP2:TX2+	Output	DFP 2 TMDS pos. diff. output, Channel 2
12	DFP2:TX2-	Output	DFP 2 TMDS neg. diff. output, Channel 2
13	RETURN	Return	Shield for TMDS Channel 2

Pin #	Signal Name	Type	Description
14	RETURN	Return	Shield for TMDS Channel 0
15	DFP2:TX0+	Output	DFP 2 TMDS pos. diff. output, Channel 0
16	DFP2:TX0-	Output	DFP 2 TMDS neg. diff. output, Channel 0
17			Reserved - Do Not Connect
18	DFP2:HOT_PLUG_ DETECT	Input	DFP 2 Hot Plug Detection
19	DFP2:DDC_DATA	Bidirectional	DFP 2 DDC Data (SDA)
20	DFP2:DDC_CLOCK	Output	DFP 2 DDC Clock (SCL)
Shell	RETURN	Return	

RS-232 1

Pin #	Signal Name	Type	Description
1			
2	SP1:TX	Output	RS-232 1 Serial Port RS-232 Transmit Signal
3	SP1:RX	Input	RS-232 1 Serial Port RS-232 Receive Signal
4			
5	RETURN	Return	RS-232 1 Serial Port RS-232 Return
6			
7			
8			
9			
Shell	RETURN	Return	

RS-232 2

Pin #	Signal Name	Type	Description
1			
2	SP2:TX	Output	RS-232 2 Serial Port RS-232 Transmit Signal
3	SP2:RX	Input	RS-232 2 Serial Port RS-232 Receive Signal
4			
5	RETURN	Return	RS-232 2 Serial Port RS-232 Return
6			
7			
8			
9			
Shell	RETURN	Return	

TRAM-NET 1

Pin #	Signal Name	Type	Description
1	TN1:RX+	Input	Tram-net 1 Receive Non inverted Diff. Signal
2	RETURN	Return	
3	TN1:RX-	Input	Tram-net 1 Receive Inverted Diff. Signal
4	+16.75V	Output	
5	TN1:TX-	Output	Tram-net 1 Transmit Inverted Diff. Signal
6	+16.75V	Output	
7			
8	RETURN	Return	
9	TN1:TX+	Output	Tram-net 1 Transmit Non inverted Diff. Signal
Shell	RETURN	Return	

TRAM-NET 2

Pin #	Signal Name	Type	Description
1	TN2:RX+	Input	Tram-net 2 Receive Non inverted Diff. Signal
2	RETURN	Return	
3	TN2:RX-	Input	Tram-net 2 Receive Inverted Diff. Signal
4	+16.75V	Output	
5	TN2:TX-	Output	Tram-net 2 Transmit Inverted Diff. Signal
6	+16.75V	Output	
7			
8	RETURN	Return	
9	TN2:TX+	Output	Tram-net 2 Transmit Non inverted Diff. Signal
Shell	RETURN	Return	

ETHERNET

Pin #	Signal Name	Type	Description
1	LAN1:TX+	Output	LAN Transmit Non inverted Differential Signal
2	LAN1:TX-	Output	LAN Transmit Inverted Differential Signal
3	LAN1:RX+	Input	LAN Receive Non inverted Differential Signal
4			
5			
6	LAN1:RX-	Input	LAN Receive Inverted Differential Signal
7			
8			

M-Port 1

Pin #	Signal Name	Type	Description
1	MP1:bRD+	Input	M-Port 1 LAN Receive Non inverted Diff. Signal
2	MP1:bRD-	Input	M-Port 1 LAN Receive Inverted Diff. Signal
3	MP1:bTD+/SID+	Output/Input	M-Port 1 LAN Transmit Non inverted Diff. Signal/AutoPort ID Signal
4	MP1:RETURN	Return	M-Port 1 Isolated +5V Return
5	MP1:bRxD	Input	M-Port 1 RS-232 Receive Signal
6	MP1:bTD-/SID-	Output/Input	M-Port 1 LAN Transmit Inverted Diff. Signal/AutoPort ID Signal Return
7	MP1:bTxD	Output	M-Port 1 RS-232 Transmit Signal
8	MP1:+5V	Output	M-Port 1 Isolated +5V output

M-Port 2

Pin #	Signal Name	Type	Description
1	MP2:bRD+	Input	M-Port 2 LAN Receive Non inverted Diff. Signal
2	MP2:bRD-	Input	M-Port 2 LAN Receive Inverted Diff. Signal
3	MP2:bTD+/SID+	Output/Input	M-Port 2 LAN Transmit Non inverted Diff. Signal/AutoPort ID Signal
4	MP2:RETURN	Return	M-Port 2 Isolated +5V Return
5	MP2:bRxD	Input	M-Port 2 RS-232 Receive Signal
6	MP2:bTD-/SID-	Output/Input	M-Port 2 LAN Transmit Inverted Diff. Signal/AutoPort ID Signal Return
7	MP2:bTxD	Output	M-Port 2 RS-232 Transmit Signal
8	MP2:+5V	Output	M-Port 2 Isolated +5V output

M-Port 3

Pin #	Signal Name	Type	Description
1	MP3:bRD+	Input	M-Port 3 LAN Receive Non inverted Diff. Signal
2	MP3:bRD-	Input	M-Port 3 LAN Receive Inverted Diff. Signal
3	MP3:bTD+/SID+	Output/Input	M-Port 3 LAN Transmit Non inverted Diff. Signal/AutoPort ID Signal
4	MP3:RETURN	Return	M-Port 3 Isolated +5V Return
5	MP3:bRxD	Input	M-Port 3 RS-232 Receive Signal
6	MP3:bTD-/SID-	Output/Input	M-Port 3 LAN Transmit Inverted Diff. Signal/AutoPort ID Signal Return
7	MP3:bTxD	Output	M-Port 3 RS-232 Transmit Signal
8	MP3:+5V	Output	M-Port 3 Isolated +5V output

M-Port 4

Pin #	Signal Name	Type	Description
1	MP4:bRD+	Input	M-Port 4 LAN Receive Non inverted Diff. Signal
2	MP4:bRD-	Input	M-Port 4 LAN Receive Inverted Diff. Signal
3	MP4:bTD+/SID+	Output/Input	M-Port 4 LAN Transmit Non inverted Diff. Signal/AutoPort ID Signal
4	MP4:RETURN	Return	M-Port 4 Isolated +5V Return
5	MP4:bRxD	Input	M-Port 4 RS-232 Receive Signal
6	MP4:bTD-/SID-	Output/Input	M-Port 4 LAN Transmit Inverted Diff. Signal/AutoPort ID Signal Return
7	MP4:bTxD	Output	M-Port 4 RS-232 Transmit Signal
8	MP4:+5V	Output	M-Port 4 Isolated +5V output

Keypad

Pin #	Signal Name	Type	Description
1	MP4:bTD+/SID+	Output/Input	M-Port 4 LAN Transmit Non inverted Diff. Signal/AutoPort ID Signal
2	MP4:RETURN	Return	M-Port 4 Isolated +5V Return
3	MP4:bRxD	Input	M-Port 4 RS-232 Receive Signal
4	MP4:bTD-/SID-	Output/Input	M-Port 4 LAN Transmit Inverted Diff. Signal/AutoPort ID Signal Return
5	MP4:bTxD	Output	M-Port 4 RS-232 Transmit Signal
6	MP4:+5V	Output	M-Port 4 Isolated +5V output

Disassembly Guidelines

General

Follow these guidelines when disassembling the monitor. You will require a standard set of hand tools.

PCB Assemblies

WARNING
Solder multilayer and surface mount PCB assemblies at your own risk! Improper repair methods can damage the PCB assemblies even further. Only qualified service personnel with the proper laboratory equipment should attempt to repair PCB assemblies.

Observe the following guidelines when handling all PCB assemblies:

- Take precautions against electrostatic discharge damage.
- Handle all PCB assemblies by their edges.

Hardware

- Before disassembly, note the positions of any wires or looms (cables), marking them if necessary to ensure that they are replaced correctly.
- Gray ribbon cables have retainer clips holding them in the connector.
- Save and set aside all hardware for re-assembly.

Opening the Unit for Service

WARNING
Patient monitoring interruption. Make sure a patient is not being monitoring.

First, turn the unit OFF at the rear power switch and disconnect the AC power cord and all communication cables.

WARNING
Due to possible high voltage present, use an insulated screwdriver at all times.

Refer to the exploded view of the unit at the end of the chapter when disassembling.

Cover

1. Remove four painted screws on the sides of the unit.
2. Lift the cover directly up.

Power Supply

1. Remove cover.
2. Disconnect cable harness between circuit boards.
3. Remove three screws that secure the aluminum mounting bracket to the chassis.
4. At the top rear of the unit, remove the two screws closest to the AC power inlet.
5. Slide the power supply forward to clear the equipotential post and lift out the power supply.

Processor Board

1. Remove the cover.
2. Remove six screws holding the rear panel. Remove the rear panel. (The processor board cannot be removed without first removing rear panel.)
3. Remove cable harness to the power supply.
4. Remove five screws holding the board to the chassis.
5. Disconnect speaker cable.
6. Slide the board toward rear to clear front of chassis.

Lithium Battery

The following error message will appear when the lithium battery fails.

“ERROR: THE INTERNAL BATTERY THAT MAINTAINS THE MONITOR’S DEFAULTS HAS FAILED!”
** * SERVICE MAY BE REQUIRED * **

When this error message appears, complete the steps listed above for the processor board. Then desolder the battery and solder in a new lithium battery.

Speaker

1. Remove the cover.
2. Using a metric hex or allen wrench with ball end, unscrew two screws.
3. Remove speaker from chassis.

Ordering Parts

The parts lists and assembly drawings in this chapter supply enough detail for you to order parts for the assemblies considered field serviceable. If you require additional information, schematics, or troubleshooting assistance, contact Technical Support.

To order parts, contact Service Parts at the address or telephone number listed on the "How to Reach Us..." page found in the front of this manual.

For the latest parts information, including substitutions, obsolescence and compatibility, please visit our Parts ID Portal website at:

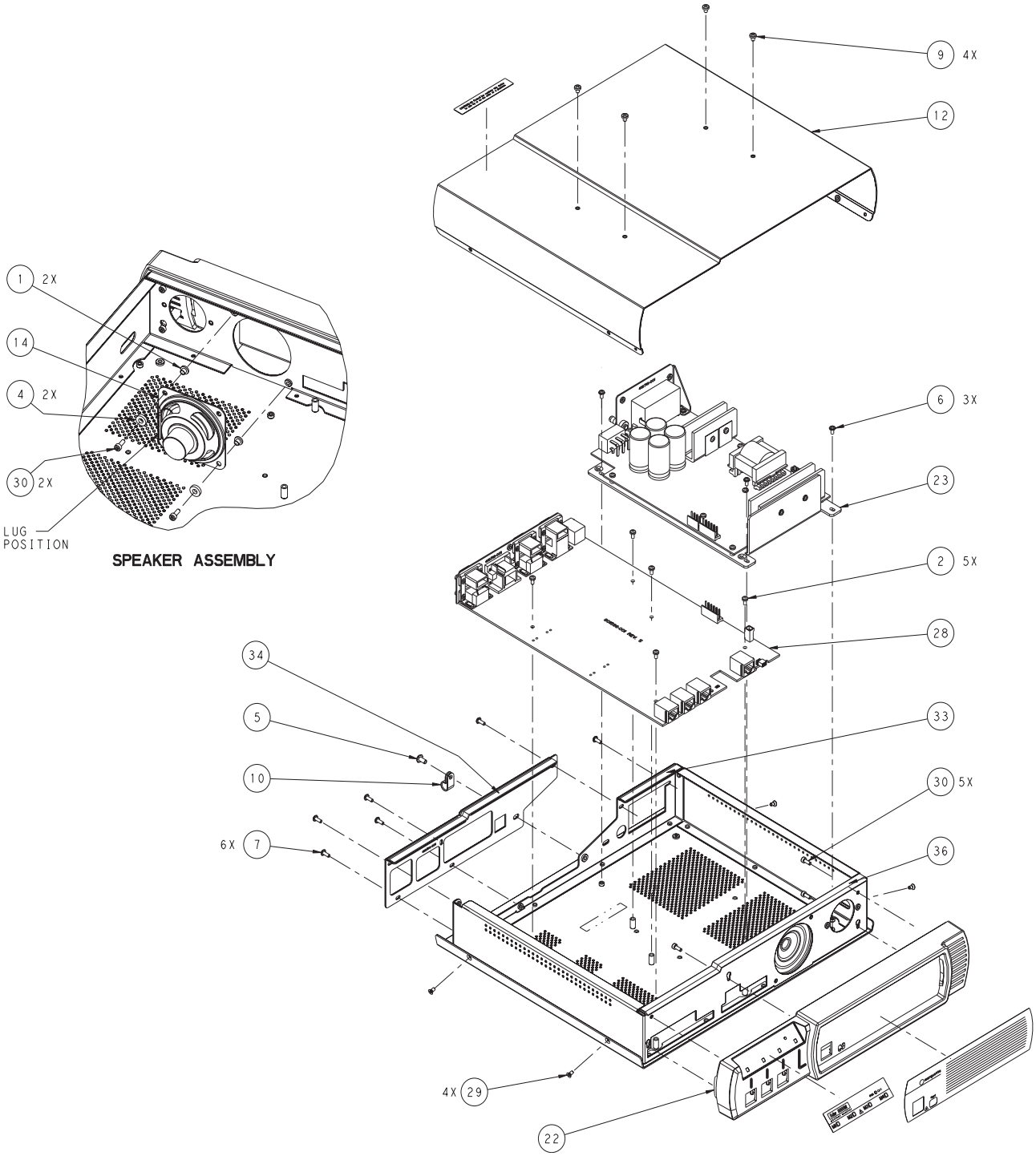
http://egems.gehealthcare.com/partsiduser/gems/Welcome.jsp

Field Replaceable Units

Field Replaceable Units		
Find Num	Item	Part Number
14	Speaker Assembly	421378-003
22	Bezel Assembly Product codes 3S & 3T (with light pipe) Product code SBH	 422810-001 422810-002
23	Power Supply Assembly	422811-001
28	For Solar 8000M single display (product codes 3T and SBH): Kit, 8000M PCB (single video) replacement with passcode includes: ■ Processor PCB Assembly 2008705-002 ■ Ethernet passcodes from MEIPWS	2009700-002
	For Solar 8000M dual display (product code 3S) ONLY : Kit, 8000M PCB (dual video) replacement with passcode includes: ■ Processor PCB Assembly 801586-002 ■ Ethernet passcodes from MEIPWS	2008650-002
-	Wire Harness (Processor to Power Supply)	422812-002
-	Label Kit Product codes 3S & 3T Product code SBH	 422825-001 422825-002
-	AutoPort to M-Port Adapter	2001973-001
-	Remote Control Holder Kit (includes holder and mounting materials)	2013770-001
-	Solar 8000M Holster	2001244-002

Solar 8000M Upper Level Assembly

Find Num	Item Number	Item Description	Qty
1		WASHER SHOULDER NYLON .1401	2
2		SCREW PH M3 X 8MM	5
4		SPACER Q3 NYLON	2
5		SCREW SEMS M4- .7X10	1
6		SCREW SEMS PH M3 X 6MM	3
7		SCREW SEMS PH M3- .5X8	6
9		SCR SL BDGH 6-32 X 3/16 NYLON	4
10	415363-001	CLAMP CABLE	1
12	418715-001	COVER SOLAR 8000M	0
29		SCR MACH FLHD M3 X 6MM SS N8.25 GRAY	4
30		SCR DIN912 M3 X 8MM ZINC VIBRA	7
33		GASKET EMI SHIELD FOAM NA-C2 E67 3.3	1
34		GASKET EMI SHIELD FOAM NA-C2 E67 9.5	1
36		GASKET EMI SHIELD FOAM NA-C2 E67 12.8	1



SPEAKER ASSEMBLY

Keypads/Remote Controls

Part Number	Description
2026967-001	Adult Keypad
2026967-002	OR Keypad
2026967-003	Neo Keypad
2026967-004	Adult Remote
2026967-005	OR Remote
2026967-006	Neo Remote

Cables

Description	Item Number
5 Foot Cable (Included with remote control.)	420857-001
10 Foot Cable	420857-002
20 Foot Cable	420857-003
50 Foot Cable	420857-004
100 Foot Cable	420857-xxx

Description	Item Number
6 Foot Serial Cable for touchscreen interface	2006733-001
10 Foot Serial Cable for touchscreen interface	2006733-002
15 Foot Serial Cable for touchscreen interface	2006733-003
25 Foot Serial Cable for touchscreen interface	2006733-004

For your notes

A Appendix A – Technical Specifications

For your notes

Solar 8000M Patient Monitor

Due to continual product innovation, specifications are subject to change without notice. The following specifications are accurate as of the date of this publication, and pertain to Solar 8000M patient monitor.

Performance Specifications

Solar 8000M Processing Unit Controls

Optional keypad with Trim Knob control and 18 active hard keys:	See Keypad for applications and specifications.
Optional remote control with Trim Knob control and 18 active hard keys:	See Remote Control for applications and specifications.
Optional touchscreen interface:	Requires touchscreen display and software.
Communications protocols:	
Tram-net	Proprietary CSMA/CD protocol at 921 Kbits/sec
Unity	Ethernet IEEE 802.3 10 BASE T LAN

Processing

Main processor:	Motorola MPC860P (PowerPC), 66 MHz, 32 bit
Graphics processor:	1 or 2 pair - Intel B69030 Graphics Accelerator with Silicon Image transmitter providing independent images on one or two VGA and DFP displays
Tram-net communication processor:	Within Motorola MPC860P (PowerPC), 66 MHz, 32 bit
LAN communication processor:	Within Motorola MPC860P (PowerPC), 66 MHz, 32 bit

Alarms

Classification:	
Patient Status Alarms — 4 levels:	Crisis, Warning, Advisory, and Message
System Status Alarms — 2 levels:	Warning and Advisory
Notification:	Audible and visual, dependent on alarm level
Display of alarm information:	All limits are viewable and printable
Continuous display of limits:	All parameters, one set of limits

Interfaces

Contact your local sales representative.

Environmental Specifications

Power requirements:	110 ±20 VAC, 50/60 Hz, single phase 230 ±40 VAC, 50/60 Hz, single phase
Power consumption:	100 Watts maximum
Low-voltage shutdown:	<90 VAC/<190 VAC
Cooling:	Natural convection
Heat dissipation:	100 BTU/hr (29.3 Watts)

Operating Conditions

Ambient temperature:	0°C to 40°C (32°F to 104°F)
Relative humidity:	15% to 95% (noncondensing)

Storage Conditions

Temperature:	-40°C to 70°C (-40°F to 158°F)
Relative humidity:	15% to 95% (noncondensing)

Physical Specifications

Height:	8.1 cm (3.2 in)
Width:	35.4 cm (13.9 in)
Depth:	33.4 cm (13.2 in)
Weight:	5.6 kg (12.3 lb)

Warranty

Standard warranty is one year. Other options are available.

Display:	The display is ordered separately from the Solar 8000M processing unit.
Display size:	15-inch to 21-inch typical
Display type:	Color
Display resolution:	1024 x 768
Sweep speed:	25 mm/sec typical (user has ability to vary speeds of individual traces)
Aspect ratio:	4 to 3 (fixed, not user-adjustable)
Frequency response:	Limited by input response of data acquisition device

Displayed Information

Number of traces:	1 to 8
Number of seconds/trace:	6.5 seconds typical (can differ if user varies speeds of individual traces)
Waveform display options:	Full, individual, or CRG Plus, EEG spectra, BIS spectra
Information window:	Displays non-realtime information without obstructing the display of real-time patient information.
Display organization:	Prioritized by parameter

*Specifications based on a complete system including a monitor (display).

Display Specifications

The Solar 8000M patient monitor is compatible with GE Medical Systems *Information Technologies* monitors (displays) and off-the-shelf monitors. Monitor specifications vary by model. For model-specific specifications, consult the monitor manufacturer's specification sheets. Your GE Medical Systems *Information Technologies* representative can provide specifications for selecting off-the-shelf monitors for use with the Solar 8000M patient monitor (display).

Due to continual product innovation, GE Medical Systems *Information Technologies* designs and specifications are subject to change without notice.

Standards Compiance	UL 60601-1 CAN/CSA C22.2 No. 601.1 EN 60601-1 EN 60601-1-2 EN 60601-2-49

Tram-rac 2 and 4A Module Housings

Processing

Data acquisition:	Intel 80C31, 8 bit, 14.7 MHz
Display communication:	Intel 80C152, 8 bit, 14.7 MHz
Communications protocol:	Tramnet, 921Kbits/sec, similar to IEEE 802.3

Analog Outputs (Tram-rac 4A only)

ECG (Tram):

Leads:	Traces one and two
Gain:	1 V/mV ± 10%
Range:	0.5 to 5 V
Frequency response:	0.05 Hz to 100 Hz

Respiration (Tram):

Lead:	Displayed lead
Gain:	1V / 1 Ohm
Range:	0.4 Ohm to 10 Ohms
Frequency response:	0.05 Hz to 2.2 Hz

Blood pressure (Tram):

Outputs:	Arterial BP, BP 2, BP 3, BP 4, signal ground
Gain:	10 mV/mmHg ± 4%
Frequency response:	DC to 50 Hz
Range:	-25 mmHg to 300 mmHg; 0 mmHg - 0.0V ± 0.025V

Pulse oximetry:

Outputs:	Value and waveform
Value gain:	10 mV / % saturation
Value range:	0 to 1 V
Waveform gain:	Fixed
Waveform range:	0 to 2.5 V
Frequency response:	DC to 50 Hz

Environmental Specifications

Tram-rac 4A Housing with optional power supply

Power requirements:	90 to 270 VAC, 50/60 Hz, single-phase
Power consumption:	70 Watts maximum, 40 Watts typical
Low-voltage shutdown:	85 VAC
Cooling:	Convection
Heat dissipation:	238 Btu/hr maximum (70 Watts)

Tram-rac 4A Housing without optional power supply

Distance from Solar 8000M:	20 feet maximum
Power requirements:	16.76 V @ 3.5 A maximum

Tram-rac 2 and 4A Housing

Operating temperature:	10°C to 35°C (50°F to 95°F)
Operating humidity:	40% to 95% (noncondensing)
Storage temperature:	-10°C to 50°C (14°F to 122°F)
Storage humidity:	0% to 95% (noncondensing)

Physical Specifications

Tram-rac 2 Housing

Height:	11.9 cm (4.7 in)
Width:	14.5 cm (5.7 in)
Depth:	31.2 cm (12.3 in)
Weight:	2.3 kg (5 lb)

Tram-rac 4A Housing

Height:	22.9 cm (9.0 in)
Width:	14.5 cm (5.7 in)
Depth:	31.8 cm (12.5 in) without power supply 37.1 cm (14.6 in) with power supply
Weight:	2.7 kg (6 lb) without power supply 3.4 kg (7.5 lb) with power supply
Standards Compliance	UL 60601-1 EN 60601-1 CAN/CSA C22.2 No. 601.1

Tram Modules and Solar Parameter Functionality

Tram Module Processing

Main Processor:	Motorola 68000, 16/32 bit, 14.75 MHz
Input/Output Processor:	Intel 80C152, 8 bit, 14.75 MHz
Data Acquisition Processor:	Intel 80C152, 8 bit, 14.75 MHz
Sp02 Processor:	Intel 80C196, 8 bit, 7.3 MHz

ECG (All modules)

Standard leads available:	I, II, III, V1 to V6, aVR, aVL, and aVF
Leads analyzed simultaneously:	Tram 451, 451M, 451N, 851, 851M, 851N: Twelve (I, II, III, V1 to V6, aVR, aVL, and aVF) All others: Four (I, II, III, and V) in multi-lead mode
Lead fail:	Identifies failed electrodes and switches to intact one(s)
Lead fail sensing current:	Active electrodes: < 25 nA each, reference electrode: <200 nA
Waveform display aspect ratio:	0.46 sec/mV (amplitude = 12 mm/mV, length = 26 mm/sec) for a 25 mm/sec sweep rate displayed on a 17-inch diagonal display
Input specifications:	
QRS detection range:	±0.5 mV to ±5 mV
Signal width:	40 ms to 120 ms (Q to S)
Heart rate range:	30 to 300 beats per minute
Input impedance:	
Common mode:	>10 M at 50/60 Hz
Differential:	>2.5 M from dc to 60 Hz
Common mode rejection:	90 dB minimum at 60 Hz
Gain accuracy:	±5% (diagnostic mode)
Linearity deviation:	±5%
Noise:	<30 μV (referred to input)
Output specifications:	
Frequency response:	Tram 451, 451M, 451N, 851, 851M, 851N: Adult mode: 0.05 to 100 Hz OR mode: 0.05 to 25 Hz Neonatal mode: 0.5 to 40 Hz All others: 0.05 or 0.5 to 100Hz (user selectable)
Analog output:	Selectable at 1V/mV
Display:	
Standard mode:	0.05 to 40 Hz
OR Mode:	0.05 to 25 Hz
Neonatal Mode:	0.5 to 40 Hz
Laser Printer:	

Standard Mode:	0.05 to 100 Hz
OR Mode:	0.05 to 25 Hz
Neonatal:	0.5 to 40 Hz
Heart rate:	
Heart rate averaging:	8 Beats
Display update interval:	2 seconds
Response time:	< 6 seconds (per AAMI EC13)
Limit alarm delay:	< 10 seconds after limit alarm condition exceeded
Heart rate alarm range:	-1 to 300 beats/minute, high limit > low limit
Arrhythmia analysis:	1 to 100 PVCs/minute
Method:	QRS morphology classification and timing based on single- or multiple-lead analysis
Arrhythmia calls:	Full, lethal only, or no arrhythmia
PVC alarm limit range:	1 to 100 PVCs/minute
ST Segment analysis:	
Measurement description:	ST segment deviation is measured and displayed for all acquired leads
ST display:	Lead label, ST deviation, current complex superimposed over a reference complex, J-point indicator and 15-minute mini-trends are shown for all acquired leads
Measurement point:	Measured at user-selectable measurement points (0, 30, 40, 50, 60, and 80 ms) following the J point
Measurement range:	-12.0 mm to + 12.0 mm
Display resolution:	0.1 mm
ST measurement averaging:	16 beats
Display update interval:	2 seconds
ST alarm limits:	± 12 mm, high limit > low limit, for any event within a lead group (inferior, lateral or anterior) that exceeds the alarm limit for that group
Pacemaker detection/rejection:	
Input voltage range	±2 mV to ±700 mV
Input pulse width	0.1 ms to 2 ms
Rise time	10 μs to 100 μs
Over/under shoot	2 mV (maximum)
Baseline drift	<0.5 V with a ±700-mV, 2-ms pacemaker pulse applied
Lead fail:	Identifies failed lead
Detection/rejection mode:	'Pace 1' or 'Pace 2' pacemaker artifact rejection or 'Off'.
Pacemaker alarms:	none specific to pacemaker
Standards Compliance:	UL 60601-1 EN 60601-1 EN 60601-2-27 CAN/CSA C22.2 No. 601.1

Respiration (All modules)

Respiration rate range:	1 to 200 breaths/minute
Impedance range:	100 to 1000 Ohms at 52.6 KHz
Detection sensitivity range:	0.4 to 10 Ohms impedance variation
Respiration rate alarm range:	1 to 200 breaths/minute
Apnea alarm range:	3 to 30 seconds
Waveform display bandwidth:	0.05 to 2.5 Hz (-3 dB)

Temperature (All modules)

Number of channels:	2
Probe type:	YSI Series 400 or 700 (determined by input cable)
Temperature range:	0°C to 45°C (32°F to 113°F)
Parameters displayed:	T1, T2
Alarms:	User-selectable upper and lower limits for T1, T2
Accuracy:	±0.1°C (25°C to 45°C) independent of sensor
Display resolution:	±0.1°C
Standards compliance:	EN 12470-4

Invasive Blood Pressure (Tram 451, 451M, 451N, 200SL, 400SL, 600SL, 250SL, 450SL, 650SL and 300 only)

Number of channels:	
Tram 451, 451M, 451N:	3/4 (4 available with Y-adapter cable)
Tram 200SL, 250SL:	2
Tram 400SL, 450SL:	3
Tram 600SL, 650SL:	4
Tram 300:	4
Transducer sites, site name and displayed values:	arterial (ART) - systolic, diastolic and mean femoral (FEM) - systolic, diastolic and mean pulmonary artery (PA) - systolic, diastolic and mean central venous pressure (CVP) - mean left atrial (LA) - mean right atrial (RA) - mean intracranial pressure (ICP) - mean umbilical arterial (UAC) - systolic, diastolic and mean umbilical venous (UVC) - mean special pressure (SP) - mean
Transducer requirements:	
Excitation voltage:	±2.5 V dc ±0.1%
Transducer output:	50 μV/V/cm Hg
Range:	–25 mmHg to 300 mmHg
Input specifications:	
Offset:	±150 mmHg

Input impedance:	
Common mode:	>100 K at 50/60 Hz
Differential:	>100 K from dc to 60 Hz
Output specifications:	
Gain:	976 ±1%
Frequency response:	dc to 50 Hz (+0/-3 dB)
Gain stability:	<±0.1%/°C, and <±0.1% over any 24 hour period
Zero balance range:	±150 mmHg
Zero balance accuracy:	±1 mmHg
Zero balance drift:	±1 mmHg over 24 hours
Common mode rejection:	>60 dB at 60 Hz
Noise:	<5 mV peak to peak from dc to 30 Hz
Accuracy:	±2% or ±1 mmHg, whichever is greater (exclusive of transducer)
Displayed frequency response:	0 to 12 Hz or 0 to 40 Hz (-3dB) user-selectable
Display scale selections:	0-30, 0-40, 0-60, 0-100, 0-160, 0-200, 0-300 mmHg
Analog output:	1 V / 100 mmHg
Alarms:	User selectable upper and lower limits for systolic, diastolic, and mean pressures; range -99 to 350 mmHg
Standards Compliance:	UL 60601-1 EN 60601-1 EN 60601-2-34 CAN/CSA C22.2 No. 601.1

Noninvasive Blood Pressure
(Tram 415, 451M, 451N, 851, 851M, 851N, 200SL, 400SL, 800A, 800SL, 250SL, 450SL, 850A, 850SL and 300 only)

Measurement technique:	Oscillometric
Displayed parameters:	Systolic, diastolic, and mean pressures, pulse rate, time of last measurement
Systolic pressure range:	
Adult:	30 to 275 mmHg
Pediatric:	30 to 240 mmHg
Neonatal:	30 to 135 mmHg
Diastolic pressure range:	
Adult:	10 to 220 mmHg
Pediatric:	10 to 200 mmHg
Neonatal:	10 to 110 mmHg
Mean pressure range:	
Adult:	20 to 260 mmHg
Pediatric:	20 to 235 mmHg
Neonatal:	20 to 125 mmHg

Cuff pressure range:	
Adult:	0 to 300 mmHg
Pediatric:	0 to 250 mmHg
Neonatal:	0 to 150 mmHg
Pressure accuracy:	
Static:	±2% or ±3 mmHg, whichever is greater
Clinical:	±5 mmHg average error 8 mmHg standard deviation
Measurement modes:	Manual, auto, and stat
Heart rate detection:	30 to 200 beats per minute
Total cycle time:	20 to 40 seconds typical (dependent on heart rate and motion artifact)
Maximum inflation pressure:	300 mmHg (adult), 250 mmHg (pediatric), 150 mmHg (neonatal)
Over-pressure valve:	Activates when cuff pressure exceeds: 300 mmHg (+30/-0 mmHg) adult, 150 mmHg (+15/-0 mmHg) neonatal
Automatic cycle times:	0 to 24 hours
Auto zero:	Zero pressure reference prior to each cuff inflation
Tubing length:	12 feet adult, 8 feet neonatal
Automatic cuff deflation:	Cycle time exceeding 3 minutes (90 seconds neonatal), power off, or cuff pressure exceeds 294 mmHg (± 6 mmHg) for adult, 250 mmHg (± 5 mmHg) for pediatric, or 147 mmHg (± 3 mmHg) for neonatal
Cuff sizes:	
Disposable:	Large adult, adult, small adult, pediatric, child, and neonatal
Reusable:	Adult thigh, large adult, adult, small adult, small adult/child, child, and infant
Alarms:	User-selectable upper and lower limits for systolic, diastolic, and mean pressures
Standards Compliance:	UL 60601-1 EN 60601-1 EN 60601-2-30 CAN/CSA C22.2 No. 601.1

Pulse Oximetry
Tram 200SL, 400SL, 600SL, 800A, 800SL and 300 (support Ohmeda probes)
Tram 250SL, 450SL, 650SL, 850A and 850SL (support Nellcor and GE Medical Systems *Information Technologies* probes)

Parameters monitored:	Arterial oxygen saturation (SpO2) and peripheral pulse rate (PPR)
Probe types:	GE Medical Systems *Information Technologies*, Nellcor, Ohmeda.
Range:	
SpO2:	0 to 100%
PPR:	20 to 300 beats per minute (±3 beats per minute)
Accuracy:	

90 to 100% SpO2:	1.5% (of overall range)
80 to 89.9% Sp02:	2.1%
60 to 79.9% Sp02:	2.4%
SpO2 < 60%:	unspecified
PPR	±1.7% of current reading (assumes constant pulse rate)
Displayed frequency response:	1.5 to 10.5 Hz
Analog output:	Selectable saturation 0 to 100% equivalent 0 to 1V
Alarm limit range:	SpO2: 0 to 105%; PPR: 0 to 350 beats per minute.
Messages sent to host:	Interference Detected, Low Light, Check Probe, Low Signal Quality, Probe Off Patient, Replace Bad Probe, Service the Module

Pulse Oximetry
Tram 451 and 851 (support GE Medical Systems *Information Technologies*probes)
Tram 451M and 851M (support Masimo SET probes)
Tram 451N and 851N (support Nellcor Oxismart XL probes)

Parameters monitored:	Arterial oxygen saturation (SpO2) and peripheral pulse rate (PPR)
Probe types:	Tram 451, 851: GE Medical Systems *Information Technologies* Tram 451M, 851M: Masimo SET Tram 451N, 851N: Nellcor Oxismart XL
Tram 451 and 851 range (GE):	
SpO2:	0 to 100%
PPR:	30 to 300 beats per minute
Tram 451M and 851M range (Masimo):	
SpO2:	30 to 100%
PPR:	25 to 240 beats per minute
Tram 451N and 851N range (Nellcor):	
SpO2:	1 to 100%
PPR:	20 to 250 beats per minute
Tram 451 and 851 accuracy (GE):	
90 to 100% SpO2:	±1.5% (of overall range)
80 to 89.9% SpO2:	±2.1%
60 to 79.9% SpO2:	±2.4%
SpO2 < 60%:	unspecified
PPR	±1.7% of current reading (assumes constant pulse rate)
Tram 451M and 851M accuracy (Masimo):	
70 to 100% SpO2:	Adult ±2, Neonatal ±3
69% or below SpO2:	Unspecified
PPR	±3 beats per minute
Tram 451N and 851N accuracy (Nellcor):	
Without motion:	
70 to 100% SpO2:	Adult ±2, Neonatal ±3
69% or below SpO2:	Unspecified
PPR	±3 beats per minute
With motion:	
70 to 100% SpO2:	±3
69% or below SpO2:	Unspecified
PPR	±5 beats per minute

Analog output:	Selectable saturation 0 to 100% equivalent 0 to 1V
Alarm limit range:	SpO2: 0 to 105%; PPR: 0 to 350 beats per minute.

Messages sent to host:

GE: *Pulse search, Poor signal quality detected, Probe is off patient, Probe or module malfunction*
Masimo: *Probe or module malfunction, Artifact detected, Probe is off patient, Low quality, Pulse search*
Nellcor: *Probe is off patient, Low quality, Pulse search*

Cardiac Output

Method:	Thermal dilution
Cardiac output range:	0.2 to 15 liters per minute
Blood temperature range:	30°C to 42°C (86°F to 107°F)
Injectate temperature range:	0°C to 30°C (32°F to 86°F)
Waveform display frequency response:	0 to 10 Hz (-3 dB)
Output parameters:	Cardiac output, blood temperature, injectate temperature, real-time cardiac output waveform
Cardiac output review:	Accept / reject individual measurements and store average
Catheter sizes:	5, 6, 7, 7.5, 8, French
Injectate volume selection:	3, 5, 10 cc

Environmental Specifications (all modules)

Power requirements:	16.75 VDC
Power consumption:	10 Watts (module alone)
Cooling:	Forced air
Heat dissipation:	Tram 451, 451M, 451N, 851, 851M, 851N: 34 Btu/hr All others: 31 Btu/hr
Operating temperature:	10°C to 35°C (50°F to 95°F)
Operating humidity:	40% to 95% (noncondensing)
Storage temperature:	-10°C to 50°C (14°F to 122°F)
Storage humidity:	0% to 95% (noncondensing)

Physical Specifications (Tram modules)

Height:	8.1 cm (3.2 in)
Width:	11.4 cm (4.5 in)
Depth:	29.5 cm (11.6 in)
Weight:	2.1 kg (4.7 lb)

Standards Compliance

UL 60601-1
CAN/CSA C22.2 No. 601.1
EN 60601-1

Dual Temperature Module (700 Series)

Performance Specifications	
Number of channels:	2
Probe type:	YSI Series 700
Temperature range:	0°C to 45°C (32°F to 113°F)
Accuracy:	±0.1°C (25°C to 45°C) independent of sensor
Display resolution:	±0.1°C
Parameters displayed:	T1, T2 and ‘Sensor Fail’ message
Environmental Specifications	
Power requirements:	16.75 VDC
Operating temperature:	10°C to 35°C (50°F to 95°F)
Operating humidity:	40% to 95% (noncondensing)
Storage temperature:	-40°C to 60°C (-40°F to 140°F)
Storage humidity:	0% to 95% (noncondensing)
Physical Specifications	
Height:	4.0 cm (1.6 in)
Width:	11.4 cm (4.5 in)
Depth:	28.6 cm (11.25 in)
Weight:	0.79 kg (1.75 lb)
Standards Compliance	EN 12470-4

Dual Temperature Module (400 Series)

Performance Specifications	
Number of channels:	2
Probe type:	YSI Series 400
Temperature range:	0°C to 45°C (32°F to 113°F)
Accuracy:	±0.1°C (25°C to 45°C) independent of sensor
Display resolution:	±0.1°C
Parameters displayed:	T1, T2 and 'Sensor Fail' message
Environmental Specifications	
Power requirements:	16.75 VDC
Operating temperature:	10°C to 35°C (50°F to 95°F)
Operating humidity:	40% to 95% (noncondensing)
Storage temperature:	-40°C to 60°C (-40°F to 140°F)
Storage humidity:	0% to 95% (noncondensing)
Physical Specifications	
Height:	4.0 cm (1.6 in)
Width:	11.4 cm (4.5 in)
Depth:	28.6 cm (11.25 in)
Weight:	0.79 kg (1.75 lb)
Standards Compliance	EN 12470-4

Capnostat Mainstream CO2 Module

Performance Specifications

Information displayed:	Inspired and expired CO2 concentrations in %, mmHg or kPa; respiratory rate, continuous CO2 waveform
Measurement range:	Pi CO2/Fi CO2: 0 to 100 Torr / 0 to 13% Pe CO2/Fe CO2: 0 to 100 Torr / 0 to 13% RR: 0 to 120 breaths/min
Accuracy:	CO2 sensor accuracy: 0 to 40 mmHg ±2 mmHg; 41 to 100 mmHg 5% of reading
Display resolution:	1 mmHg
Respiration rate accuracy:	±1 breath/min
Rise time	
CO2 rise time:	Less than 60 msec
Compensations	
O2/N2O compensation:	Operator selectable
Barometric pressure compensation:	Manual as set in monitor
Technology	
Sensor:	Mainstream non-dispersive infrared (NDIR) absorption, dual wavelength ratiometric-true single beam optics
Calibration:	Simple one-step calibration (less than 20 seconds); no calibration gases required.
Alarms	
Type:	As set in monitor
CO2:	High inspired CO2; high/low expired CO2
Respiratory rate:	Adjustable high and low No breath detection system On screen obstruction alarm
Temporary silence:	60 sec
Reset:	Automatic
Cable length:	10 feet (3.04 m)
Construction:	Durable high performance plastic sensor with flexible cable
Shock resistance:	Sensor designed to withstand 6-foot (2 m) drops to a tile surface
Airway adapters	
Adult:	Reusable adult airway adapter, less than 5 cc dead space (pn 412341-001)
Low volume:	Reusable airway adapter, less than 0.5 cc deadspace (pn 412342-001)

Environmental Specifications

Operating conditions

Ambient temperature:	15°C to 35°C (59°F to 95°F)
Relative humidity:	10% to 95% (noncondensing)

Storage conditions

Temperature:	0°C to 50°C (32°F to 122°F)
Relative humidity:	0% to 95% (noncondensing)

Physical Specifications

Module

Height: 4.0 cm (1.6 in)	Depth: 28.6 cm (11.25 in)
Width: 11.4 cm (4.5 in)	Weight: 0.50 kg (1.11 lb)

Sensor

Height: 4.0 cm (1.60 in)	Depth: 2.2 cm (.87 in)
Width: 3.7 cm (1.45 in)	Weight: <28 grams (<1 oz)

Standards Compliance

UL 60601-1
CAN/CSA C22.2 No. 601.1
EN 60601-1

SvO2 Module Technical Specifications

Performance Specifications

Display

Display:	SvO2, a-vO2, three asterisk signal strength indicator and help messages
Messages:	Warming Up, Calibration Takes Up to 60 Seconds, Do Light Calibration, Light Intensity Calibration, Preinsert Calibration Fail, Damped Intensity, High Intensity, Low Intensity, Blood Gas Calibration Fail, Draw Blood, Waiting for Blood Gas.

Processing

SvO2 range:	0% to 100%
Response time:	90% response to oxygen saturation step function in 5 sec. Oxygen saturation computed each second from 5 second running average of light intensity measurement
SvO2 accuracy:	±2% oxygen saturation ±1 standard deviation over 40% to 100% range
Stability:	Drift <2% oxygen saturation over 24 hours
Data acquisition rate:	244 sets of samples/sec

Alarms

Type:	Audible and visual

Environmental Specifications

Operating conditions

Ambient temperature:	10°C to 35°C (50°F to 95°F)
Relative humidity:	40% to 95% (noncondensing)

Storage Conditions

Temperature:	-10°C to 50°C (14°F to 122°F)
Relative humidity:	0% to 95% (noncondensing)

Physical Specifications

Height: 4.1 cm (1.6 in)	Depth: 28.6 cm (11.2 in)
Width: 11.4 cm (4.5 in)	Weight: 0.50 kg (1.11 lb)

Standards Compliance

UL 60601-1
CAN/CSA C22.2 No. 601.1
EN 60601-1

Masimo SET Module Technical Specifications

Performance Specifications

Display Messages	*ARTIFACT DETECTED, LOW QUALITY, PROBE IS OFF THE PATIENT, PROBE OR MODULE MALFUNCTION, POOR SIGNAL QUALITY DETECTED, PULSE SEARCH*
Measurement Range	
Saturation:	1 to 100% SpO_2
Pulse Rate:	25 to 240 bpm
Perfusion:	0.02 to 20%
Accuracy	
Saturation, no motion:	SpO_2 over the range 70 to 100%, below 69% is unspecified ±2 digits for adults and pediatrics, ±3 digits for neonates
Saturation, motion:	SpO_2 over the range 70 to 100%, below 69% is unspecified ±3 digits for adults, pediatrics, and neonates
Pulse Rate, no motion:	25 to 240 bpm, ±3 bpm
Pulse Rate, motion:	25 to 240 bpm, ±5 bpm

Power Requirements

Maximum Power Consumption	+16.5V, 150mA
(non-isolated)	+5V, 150mA

Environmental Specifications

Operating Conditions	
Temperature:	0°C to 40°C (32°F to 104°F)
Relative Humidity:	15 to 90% (non-condensing)
Storage Conditions	
Temperature:	–40°C to +70°C (–40°F to +140°F)
Relative Humidity:	0 to 95% (non-condensing)
Altitude:	-305 to 1830m (-1000 to 6,000ft.)
Atmospheric Pressure:	645 to 795mmHg (860 to 1060hPa)

Alarm Specifications

Alarm Limit Range:	SpO2: 1% to 105% Pules: 40 BPM to 235 BPM
Type:	Audible Visual

Physical Specifications

Height:	4.0 cm (1.6 in)
Width:	11.4 cm (4.5 in)
Depth:	28.6 cm (11.25 in)
Weight:	0.50 Kg (1.11 lb)
Cooling Method:	Natural convection
Heat Dissipation:	8.75Btu/Hr (2.5W), maximum

Standards Compliance	UL 60601-1 CAN/CSA C22.2 No. 601.1 EN 60601-1
Warranty	One year (accessories may differ)

ICG Module Technical Specifications

Performance Specifications

Measurement Range	
Cardiac Output (CO):	0 to 30 L/min
Cardiac Index (CI):	0 to 15 L/min/m^2
Stroke Volume (SV):	0 to 250 mL
Stroke Index (SI):	0 to 125 mL/m^2
Acceleration Index (ACI):	0 to 400 1/100s^2
Thoracic Fluid Content (TFC):	10 to 150 1/kΩ
Pre-Ejection Period (PEP):	0 to 1000 milliseconds
Left Ventricular Ejection Time (LVET):	0 to 1500 milliseconds
Systolic Time Ratio (STR):	0 to 1
Velocity Index (VI):	0 to 200 1/1000s
Systemic Vascular Resistance (SVR):	0 to 5000 dyne·sec·cm^{-5}
Indexed Systemic Vascular Resistance	0 to 10,000 dyne·sec·cm^{-5}/m^2
(SVRI):	0 to 200 g·m/m^2
Left Stroke Work Index (LSWI):	0 to 25 kg·m/m^2
Indexed Left Cardiac Work (LCWI):	40 to 250 beats/min
Heart Rate (HR):	

Power Requirements

Maximum Power Consumption:	+16.5 volts, 610 mA
(non-isolated)	+5.0 volts, 135 mA

Environmental Specifications

Operating Conditions	Refer to the monitor specifications.
Storage Conditions	
Temperature:	–40°C to +70°C (–40°F to +160°F)
Relative Humidity:	0 to 95% (non-condensing)
Altitude:	-305 to 3353m (-1000 to 11,000ft.)
Atmospheric Pressure:	645 to 795mmHg (860 to 1060hPa)

Physical Specifications

Height:	4.0 cm (1.6 in)
Width:	11.4 cm (4.5 in)
Depth:	28.6 cm (11.25 in)
Weight:	1.0 kg (2.2 lb) maximum
Cooling Method:	Forced Air
Heat Dissipation:	9W maximum

Compatible Host Monitors, Tram-racs

Host Monitor/Tram-rac	Software Version
Solar 7000:	7A or later
Solar 8000:	7A or later
Tram-rac 4A:	6A or later
Tram-rac 2A:	1A or later

Standards Compliance	UL 60601-1 CAN/CSA C22.2 No. 601.1 EN 60601-1
Warranty	One year (accessories may differ)

BIS/EEG Module Technical Specifications

Performance Specifications

Measurement Range

Suppression Ratio (SR):	0.0-100.0% (in 0.1% steps over the last 63 seconds)
Spectral Edge Frequency (SEF):	0.50-30.00 Hz @ 95% in 0.01 Hz steps
Median Frequency:	0.50-30.00 Hz @ 50% in 0.01 Hz steps, DSC4 only
Bispectral Index (BIS):	0-100.0 in 0.1 steps, DSC3 only
Total Power (TOTPOW):	0-100.0 dB in 0.01 dB units where 0 dB = 0.0001 mV^2
Electromyogram (EMG):	0.0-100.0 dB in 0.01 dB units where 0 dB = 0.0001 mV^2
Signal Quality Index (SQI):	0.0-100.0% in 0.1% steps

EEG Waveforms

Number of channels:	BIS DSC: 1 or 2 channels EEG DSC: 1, 2 or 4 channels
Sampling rate:	Normal mode: 128 or 256 sps

Transmission of EEG waveforms may be enabled or disabled with a software command.

Filter options for filtered EEG waveforms sent to host monitor (256 samples/second only)

Normal mode	High-pass: 0.25, 1.0, 2.0 Hz Low-pass: none, 30, 50, 70 Hz Notch: none, 50, 60, 50 & 60 Hz

Power Requirements

Maximum Power Consumption	+16.5V, 300mA
(non-isolated	+5V, 2mA

Environmental Specifications

Operating Conditions	Refer to the monitor specifications.
Storage Conditions	
Temperature:	–40°C to +70°C (–40°F to +140°F)
Relative Humidity:	0 to 95% (non-condensing)
Altitude:	–305 to 1830m (–1000 to 6,000ft.)
Atmospheric Pressure:	645 to 795mmHg (860 to 1060hPa)

Alarm Specifications

Alarm Limit Range:	BIS: –1 to 100
Type:	Audible and visual

Physical Specifications

Height:	4.0 cm (1.6 in)
Width:	11.4 cm (4.5 in)
Depth:	28.6 cm (11.25 in)
Weight:	0.52 Kg (1.15 lb)
Cooling Method:	Natural convection
Heat Dissipation:	20Btu/Hr (6W), maximum

Standards Compliance	UL 60601-1 CAN/CSA C22.2 No. 601.1 EN 60601-1 EN 60601-2-26
Warranty	One year (accessories may differ)

Solar 8000M Display

The Solar 8000M patient monitor is currently available with the following GE Medical Systems *Information Technologies* displays:

- 15-inch, medical-grade, flat panel, color LCD display
- 15-inch, medical-grade, analog flat panel with touchscreen, color LCD display
- 15-inch, medical-grade, analog/digital flat panel, color LCD display
- 18-inch, medical-grade, color LCD display

Off-the-shelf (computer-grade) displays are also compatible (see the required and recommended specifications in this chapter).

WARNING
Do not connect a monochrome display to the Solar 8000M monitor. Visual alarm messages may not appear properly.

Purchaser's Responsibility

The display purchaser is responsible for meeting Solar 8000M display specifications. GE Medical Systems *Information Technologies* does not make recommendations regarding specific display models other than those it offers for sale. For questions regarding display specifications or compatibility of displays not purchased from GE Medical Systems *Information Technologies*, contact the display manufacturer.

The GE Medical System *Information Technologies* warranty only applies to equipment purchased from GE Medical Systems *Information Technologies*. Service repairs resulting from failures of equipment not purchased from GE Medical Systems *Information Technologies* are billable.

NOTE
An isolation transformer must be used with a computer-grade display to meet UL and EN specifications.

Medical-Grade Displays

The Solar 8000M patient monitor with a medical-grade display meets applicable UL and EN specifications for a medical electrical system. For this system, an isolation transformer is not required.

Computer-Grade Displays

The Solar 8000M patient monitor with a computer-grade display meets UL and EN specifications if an isolation transformer is used, regardless of whether the computer-grade display meets the leakage current specification on its own.

The party assembling or modifying the medical electrical system is responsible to insure compliance with EN 60601-1-1. Therefore, if GE Medical Systems *Information Technologies* installs a Solar 8000M system with a computer-grade

display, GE Medical Systems *Information Technologies* is responsible for meeting the specification.

As a result GE Medical Systems *Information Technologies* only installs computer-grade displays with appropriate isolation transformers. (See the following information.)

Isolation Transformers

Powervar has designed an isolation transformer specifically for this application. Powervar headquarters (listed below) will process orders and drop-ship to any destination requested. When calling Powervar, identify yourself as a GE Medical Systems *Information Technologies* representative/customer to receive the GE Medical Systems *Information Technologies* partnership discount.

Powervar
28457 North Ballard Drive, Suite C
Lake Forest, Illinois 60045
Phone: 847-816-8585
Fax: 847-816-8988

Contact your local sales/service representative for part numbers and unit information.

Required Specifications for Analog Flat Panel or CRT Displays

The following are **required** specifications:

Electrical:		
Horizontal:	Sync Rate:	48.4 KHz (*see note)
	Sync Input:	TTL negative
Vertical:	Refresh Rate:	60 Hz (*see note)
	Sync Input:	TTL negative
Video:	Non-composite:	0.7Vp-p analog RGB
	Polarity:	Black-negative
	Resolution:	1024 x 768
	Input Impedance:	75 ohms

NOTE

Multiscan displays indicate the sync rate and the refresh rate as ranges (e.g., 20 KHz to 80 KHz), rather than a single value. To meet the required specifications, ensure that the ranges indicated on your display include a 48.4 KHz horizontal sync rate and a 60 Hz vertical refresh rate.

Monitor (Display) Connections:	
Captive cable, or interconnect cable (processor unit to display):	
	15 pin (3 row) Dsub male connector, standard VGA pinout
Connector(s):	15 pin (3 row) Dsub female connector, standard VGA pinout; or 5 BNC connectors
EMC:	FCC Part 15 Class B, EN 55022, EN 55024, EN 61000-3-2, EN 61000-3-3
Agency Approvals:	UL 60950, CSA 950, EN 60950, CE

Recommended Specifications for Computer-Grade CRT Displays

The following are **recommended** specifications:

Monitor (Display) Size:	12-inch to 19-inches typical
Input Voltage Range:	90-135 VAC/60 Hz, or 180-270 VAC/50 Hz
Controls:	On/Off, Brightness, Contrast
Environmental:	
Operating Temperature:	10 to 40 degrees C
Humidity:	10 to 95% (non-condensing)
Bandwidth:	60 MHz minimum
Dot Pitch:	0.28 mm maximum
Misconvergence:	0.3 mm maximum
Non-linearity/Geometric Distortion:	2% maximum
Luminance:	>40 foot-lamberts at screen center with 20% white screen
CRT:	Anti-glare coating and transmissiveness of approximately 57%
Mounts:	If the monitor (display) will be mounted, it must accommodate GCX or equivalent mounting GCX Corporation 32 Pamaron Way Novato, CA 94949 415-883-2551
Agency Approvals:	Refer to "Computer-Grade Displays" on page A-25

Required Specifications for Digital Flat Panel Displays

The following are **required** specifications:

Electrical:		
Horizontal:	Sync Rate:	48.4 KHz (*see note)
	Sync Input:	TTL negative
Vertical:	Refresh Rate:	60 Hz (*see note)
	Sync Input:	TTL negative
Video:	TMDS Digital Video DFP 1.0 Compliant	
	Resolution:	1024 x 768

NOTE

Multiscan displays indicate the sync rate and the refresh rate as ranges (e.g., 20 KHz to 80 KHz), rather than a single value. To meet the required specifications, ensure that the ranges indicated on your display include a 48.4 KHz horizontal sync rate and a 60 Hz vertical refresh rate.

Monitor (Display) Connections:	
Captive cable, or interconnect cable (processor unit to display):	
	20 pin mini-D ribbon (MDR) male connector
Connector(s):	20 pin mini-D ribbon (MDR) female connector
EMC:	FCC Part 15 Class B, EN 55022, EN 55024, EN 61000-3-2, EN 61000-3-3
Agency Approvals:	UL 60950, CSA 950, EN 60950, CE

Recommended Specifications for Computer-Grade Digital Flat Panel Displays

The following are **recommended** specifications:

Monitor (Display) Size:	15-inch to 21-inches typical
Display Characteristics:	Viewing angle ± 70° horizontal minimum; ± 70° vertical minimum
Input Voltage Range:	90-135 VAC/60 Hz, or 180-270 VAC/50 Hz
Controls:	On/Off, Brightness
Environmental:	
Operating Temperature:	10 to 40 degrees C
Humidity:	10 to 95% (non-condensing)
Bandwidth:	65 MHz minimum
Contrast Ratio:	300:1 typical
Brightness:	150 nits minimum
Protective Filter:	Anti-glare hard coat
Mounts:	If the monitor (display) will be mounted, it must accommodate GCX or equivalent mounting GCX Corporation 32 Pamaron Way Novato, CA 94949 415-883-2551
Agency Approvals:	Refer to "Computer-Grade Displays" on page A-25

B Electromagnetic Compatibility

For your notes

Electromagnetic Compatibility (EMC)

Changes or modifications to this system not expressly approved by GE Medical Systems can cause EMC issues with this or other equipment. This system is designed and tested to comply with applicable regulation regarding EMC and must be installed and put into service according to the EMC information stated in this supplement.

WARNING
Use of portable phones or other radio frequency (RF) emitting equipment near the system may cause unexpected or adverse operation.

WARNING
The equipment or system should not be used adjacent to, or stacked with, other equipment. If adjacent or stacked use is necessary, the equipment or system should be tested to verify normal operation in the configuration in which it is being used.

Guidance and Manufacturer's Declaration — Electromagnetic Emissions

The Solar 8000M is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the Solar 8000M is used in such an environment.

Emissions Test	Compliance	Electromagnetic Environment – Guidance
RF Emissions EN 55011	Group 1	The equipment uses RF energy only for its internal function. Therefore, its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.
RF Emissions EN 55011	Class A	The equipment is suitable for use in all establishments other than domestic and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic Emissions EN 61000-3-2	Class A	
Voltage Fluctuations/ Flicker Emissions EN 61000-3-3	Complies	

Guidance and Manufacturer's Declaration — Electromagnetic Immunity

The Solar 8000M is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the Solar 8000M is used in such an environment.

Immunity Test	EN 60601 Test Level	Compliance Level	Electromagnetic Environment – Guidance
Electrostatic Discharge (ESD) EN 61000-4-2	± 6 kV contact ± 8 kV air	± 6 kV contact ± 8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%.
Electrical Fast Transient/Burst EN 61000-4-4	± 2 kV for power supply lines ±1 kV for input/output lines	± 2 kV for power supply lines ±1 kV for input/output lines	Mains power should be that of a typical commercial or hospital environment.
Surge EN 61000-4-5	± 1 kV differential mode ± 2 kV common mode	± 1 kV differential mode ± 2 kV common mode	Mains power should be that of a typical commercial or hospital environment.
Voltage dips, short interruptions and voltage variations on power supply input lines EN 61000-4-11	<5% U_t (>95% dip in U_t) for 0.5 cycles <40% U_t (>60% dip in U_t) for 5 cycles <70% U_t (>30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 s	<5% U_t (>95% dip in U_t) for 0.5 cycles <40% U_t (>60% dip in U_t) for 5 cycles <70% U_t (>30% dip in U_t) for 25 cycles <5% U_t (>95% dip in U_t) for 5 s	Mains power should be that of a typical commercial or hospital environment. If the user of the equipment requires continued operation during power mains interruptions, it is recommended that the equipment be powered from an uninterruptible power supply or a battery.
Power Frequency (50/60 Hz) Magnetic Field EN 61000-4-8	3 A/m	3 A/m	Power frequency magnetic fields should be at levels characteristic of a typical location in a typical commercial or hospital environment.

NOTE

U_t is the AC mains voltage prior to application of the test level.

Guidance and Manufacturer's Declaration — Electromagnetic Immunity

The Solar 8000M is intended for use in the electromagnetic environment specified below. It is the responsibility of the customer or user to assure that the Solar 8000M is used in such an environment.

Immunity Test	EN 60601 Test Level	Compliance Level	Electromagnetic Environment – Guidance
			Portable and mobile RF communications equipment should not be used closer to any part of the equipment, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter. Recommended separation distance
Conducted RF EN 61000-4-6	3 Vrms 150 KHz to 80 MHz	3 V rms	$d = 1.2\sqrt{P}$
Radiated RF EN 61000-4-3	3 V/m 80 MHz to 2.5 GHz	3 V/m	$d = 1.2\sqrt{P}$ 80 MHz to 800 MHz $d = 2.3\sqrt{P}$ 800 MHz to 2.5 GHz where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer, and d is the recommended separation distance in meters (m). Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey[a], should be less than the compliance level in each frequency range[b]. Interference may occur in the vicinity of equipment marked with the following symbol:

Note 1: At 80 MHz and 800 MHz, the higher frequency range applies.

Note 2: These guidelines may not apply in all situations. Electromagnetic propagation is affected by reflection from structures, objects, and people.

[a] Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radio, AM and FM radio broadcast, and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the equipment is used exceeds the applicable RF compliance level above, the equipment should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the equipment.

[b] Over the frequency range 150 KHz to 80 MHz, field strengths should be less than 3 V/m.

Recommended Separation Distances

The table below provides the recommended separation distances (in meters) between portable and mobile RF communications equipment and the Solar 8000M.

The Solar 8000M is intended for use in the electromagnetic environment on which radiated RF disturbances are controlled. The customer or the user of the Solar 8000M can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the Solar 8000M as recommended below, according to the maximum output power of the communications equipment.

	Separation Distance in Meters (m) According to Frequency of Transmitter		
Rated Maximum Output Power of Transmitter in Watts	150 kHz to 80 MHz [a] $d = 1.2\sqrt{P}$	80 MHz to 800 MHz [a] $d = 1.2\sqrt{P}$	800 MHz to 2.5 GHz [a] $d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.23
0.1	0.38	0.38	0.73
1	1.2	1.2	2.3
10	3.8	3.8	7.3
100	12	12	23

[a]At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

For transmitters rated at a maximum output power not listed above, the recommended separation distance [*d*] in meters (m) can be estimated using the equitation applicable to the frequency of the transmitter, where *P* is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE

These guidelines may not apply in all instances. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

Compliant Cables and Accessories

WARNING
The use of accessories, transducers and cables other than those specified may result in increased emissions or decreased immunity performance of the equipment or system.

The table below lists cables, transducers, and other applicable accessories with which GE Medical Systems claims EMC compliance.

NOTE
Any supplied accessories that do not affect EMC compliance are not included.

Description	Maximum Length
ECG Cables	
Multi-Link 12-Ld ECG Standard Cable	3.6 m / 12 ft
Multi-Link 5-Ld ECG Standard Cable	6 m / 20 ft
Multi-Link 3-Ld ECG Neonatal Cable	3.6 m / 12 ft
Multi-Link 3-Ld ECG Cable w/Grabber	3.6 m / 12 ft
Multi-Link 5-Ld ECG ESU	3.6 m / 12 ft
Multi-Link, 3/5-Ld ECG Cable	3.6 m / 12 ft
Multi-Link 3-Ld Neonatal ECG Cable	3.6 m / 12 ft
Multi-Link 3-Ld ECG Cable w/Grabber	3.6 m / 12 ft
Multi-Link 6-Ld ECG Cable	3.6 m / 12 ft
Multi-Link 12SL ECG Cable	3.6 m / 12 ft
Multi-Link 3/5/6 Adapter	N/A
Multi-Link to 300-Series 3-Ld Trunk Cable	3 m / 10 ft
Multi-Link to 300-Series 5-Ld Trunk Cable	3 m / 10 ft
ECG Multi-Link Leadwires	
Multi-Link leadwire Set-Group, 5-Ld, Grabber	130 cm / 51 in
Multi-Link leadwire Set-Group, 3-Ld, Grabber	130 cm / 51 in
Multi-Link leadwire set, 5-Ld, Grabber	130 cm / 51 in
Multi-Link leadwire set, 5-Ld, Grabber V2-V6	130 cm / 51 in
Multi-Link leadwire set, 3-Ld, MiniGrab AHA Ld I	74 cm / 29 in
Multi-Link leadwire set, 3-Ld, MiniGrab IEC Ld I	74 cm / 29 in
Multi-Link leadwire set, 3-Ld, Adult Grabber AHA Ld II	74 cm / 29 in
Multi-Link leadwire set, 3-Ld, Adult Grabber IEC Ld II	74 cm / 29 in

Description	Maximum Length
Multi-Link Ldwr Set-Group, 5-Ld, Snap	130 cm / 51 in
Multi-Link Ldwr Set-Group, 3-Ld, Snap	130 cm / 51 in
Multi-Link Ldwr Set, Mini-Clip/DIN, Neonatal	60 cm / 24 in
Multi-Link Ldwr Set, 5-Ld, Snap	130 cm / 51 in
Multi-Link Ldwr Set, Radiotranslucent Grabber	1.6 m / 60 in
Multi-Link Ldwr Set, 6-Ld, Snap	130 cm / 51 in
Multi-Link Ldwr Set, Individual, Grabber	130 cm / 51 in
Multi-Link Ldwr Set, Individual, Snap	130 cm / 51 in
Multi-Link Ldwr Set, Individual, Grabber, V2-V6	130 cm / 51 in
300-Series 3-Ld Set w/clips	75 cm / 30 in
300-Series 3-Ld Set w/clips	1.5 m / 60 in
300-Series 3-Ld Set w/snaps	75 cm / 30 in
300-Series 5-Ld Set w/clips	125 cm / 49 in
300-Series 5-Ld Set w/clips	1.5 m / 60 in
300-Series 5-Ld Set w/snaps	125 cm / 49 in
300-Series replacement clip lead	125 cm / 49 in
300-Series replacement clip lead	1.5 m / 60 in
300-Series replacement clip lead	75 cm / 30 in
300-Series replacement snap lead	125 cm / 49 in
Invasive BP Cables and Transducers	
Utah Transducer Adapter Cable	3.6 m / 12 ft
Spectramed Transducer Adapter Cable	3.6 m / 12 ft
Dual BP adapter	30 cm / 12 in
Utah Transducer Adapter Cable	3.6 m / 12 ft
Abbott Transpac-III Adapter Cable	3.6 m / 12 ft
Abbott Transpac-IV Adapter Cable	3.6 m / 12 ft
Edwards Truwave Adapter Cable	3.6 m / 12 ft
Spectramed Transducer Adapter Cable	3.6 m / 12 ft
Utah Disposable Transducers (DPT, DP2, DP3)	N/A
Spectramed Transducers (TC-MQ)	N/A
Abbott Transpac-III Transducers	N/A
Abbott Transpac-IV Transducers	N/A

Description	Maximum Length
Edwards Truwave Transducers (PX)	N/A
Cardiac Output Cables and Probes	
Cardiac Output Cable	3.6 m / 12 ft
Cardiac Output Probe	2.4 m / 8 ft
Cardiac Output Cable	3.6 m / 12 ft
Temperature Cables and Probes	
Dual Temp Cable	20 cm / 8 in
Temp Probe Interconnect Cable	3.6 m / 12 ft
Dual Temp Cable	20 cm / 8 in
Pulse Oximetry Cables and Sensors	
Nellcor RECAL Interface Cable	3.6 m / 12 ft
Masimo SET Interface Cable	3.6 m / 12 ft
Masimo SET Interface Cable	3.6 m / 12 ft
Nellcor RCAL Interface Cable	3.6 m / 12 ft
Nellcor OxiMax Interface Cable	3 m / 10 ft
Masimo Finger Sensor, Pediatric	N/A
Masimo Finger Sensor, Adult	N/A
Masimo Sensor Finger Probe	N/A
ICG Cable	
ICG Patient Cable	4.8 m / 15 ft
BIS/EEG Cables	
BIS DSC w/PIC Plus	N/A
EEG DSC w/leadwires	N/A
EEG DSC Extension Cable	6 m / 20 ft
TC Cable	
Radiometer E5280 Patient Cable	N/A
SvO_2 Cable	
Abbott Optical Module	N/A
CO_2	
CO_2 Sensor Cable	2.4 m / 8 ft
Accessories	
TRAM Modules	N/A

Description	Maximum Length
Transcutaneous (TC) Module	N/A
SvO_2 Module	N/A
MGAIR Sidestream CO_2 Module	N/A
Capnostat Mainstream CO_2 Module	N/A
BIS/EEG Module	N/A
SpO_2 Module	N/A
SAM Module	N/A
ICG -BIOz Hemodynamics Module	N/A
Masimo SET Pulse Oximetry Module	N/A
Dual Temperature Module	N/A
Dual BP Module	N/A
Tram-rac Series	N/A
Unity Network ID	N/A
Respiratory Mechanics Module	N/A
PRN 50 Printer	N/A
Tram-net Cable	7.6 m / 25 ft
RJ45 series Category 5 cable	N/A
Remote Control	N/A
Key Pad	N/A
Power Cord	1.8 m / 6 ft
Power Cord	2.4 m / 8 ft
Digital Video Cable	1.8 m / 6 ft
Touch Cable RS232	1.8 m / 6 ft
Analog Video Cable	1.8 m / 6 ft
18-inch Medical Grade Flat Panel Display	N/A
15-inch Medical Grade Flat Panel Display	N/A
15-inch Medical Grade Flat Panel Display	N/A

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